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Traffic Information Collection and Integration
Developments and Directions

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Workshop Description

Effective navigation is dependent on accurate and timely traffic congestion and traffic flow information. Loop sensors and cameras provide dependable data on the roadways where they are installed, but they are expensive to put in place and to maintain. This workshop will look at the potential for expanding real-time traffic data collection systems to cover more roadways and provide more up-to-date information for navigation systems.

The causes of traffic congestion have been catalogued by government agencies around the world in countless reports and documents. They all say about the same thing, that approximately one-half of the causes are predictable (recurring and non-recurring events and poor signal timing), and the other half are inevitable (incidents, weather, work zones). Current traffic collection methods have focused on the inevitable. New systems, such as mobile phone tracking, will focus on integrating predictive traffic data into the mix of information provided in navigation system databases. This workshop will explore these new systems and their possible impact.

Improved data collection methods will require improvements in the way traffic information is delivered. The current RDS-TMC message broadcasting has proved surprisingly robust. However, message size and pre-coding of locations have always been troublesome, and are proving to be obstacles to expanding both quantity and quality of data delivery. New methods are emerging for referencing the locations of incidents and for coding traffic and other information methods. There are also new technologies becoming available for delivering these messages to vehicles. This workshop will explore all of these new possibilities.

The Workshop

- What causes traffic congestion?
- What does does traffic measuring try to accomplish?
- Who is playing in the traffic congestion monitoring field?
- Is there an innovation waiting to be monetized?
- This workshop will look at the potential for expanding real-time traffic data collection systems to cover more roadways and provide more up-to-date information for navigation systems.

Just a reminder

Means of Transportation to Work: 1990 and 2000

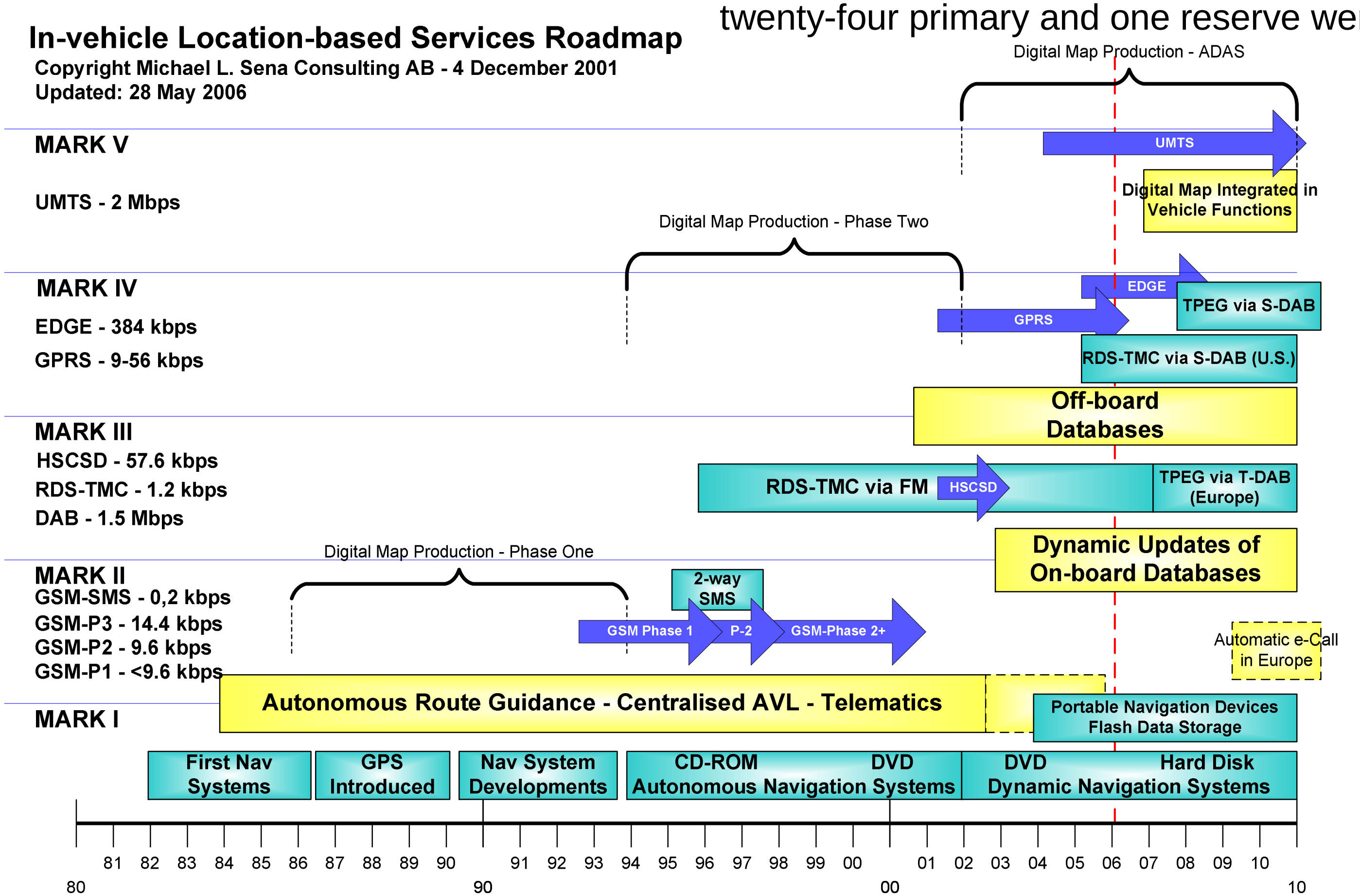
Means of Transportation	1990 %	2000 %	Change %
Car, truck or van	86.5	87.9	1.3
Drove alone	73.2	75.7	2.5
Carpooled	13.4	12.2	-1.2
Bus	3.0	2.5	-0.5
Streetcar or trolley	0.1	0.1	-
Subway or elevated	1.5	1.5	-
Railroad	0.5	0.5	-
Ferryboat	-	-	-
Taxicab	0.2	0.2	
Motorcycle	0.2	0.1	-0.1
Bicycle	0.4	0.4	-
Walked	3.9	2.9	-1.0
Other means	0.7	0.7	-
Worked at home	3.0	3.3	0.3

Traffic congestion is not new, but it has gone from being an exceptional event to an everyday affair.

Source: U.S. Census Bureau, 1990 Census Summary Tape File 3 and Census 2000 Summary File 3

…and another reminder

The first GPS satellite was put into orbit in February 1978. the first civilian use of the system came in 1984, but full-fledged use began in July 1995 when the full complement of twenty-four primary and one reserve were in orbit.



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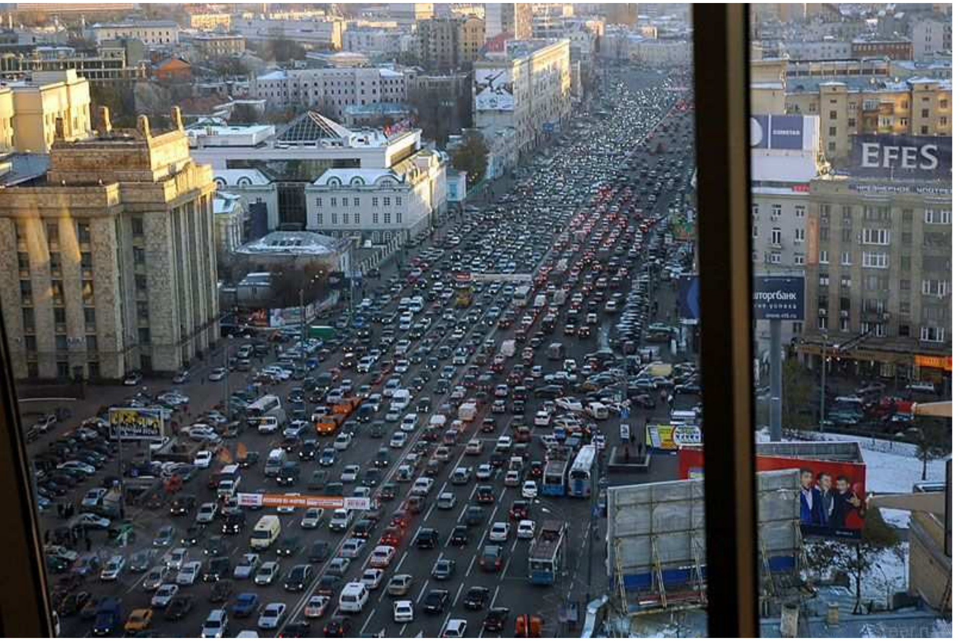
Premises

- Effective navigation is dependent on accurate and timely traffic congestion and traffic flow information.
- Loop sensors and cameras provide dependable data on the roadways where they are installed, but they are expensive to put in place and to maintain.
- The causes of traffic congestion have been catalogued by government agencies around the world in countless reports and documents. They all say about the same thing.
- Approximately one-half of the causes are **predictable** (recurring and non-recurring events and poor signal timing), and the other half are **inevitable** (incidents, weather, work zones).



A typical main street in Moscow
It's like this every weekday.

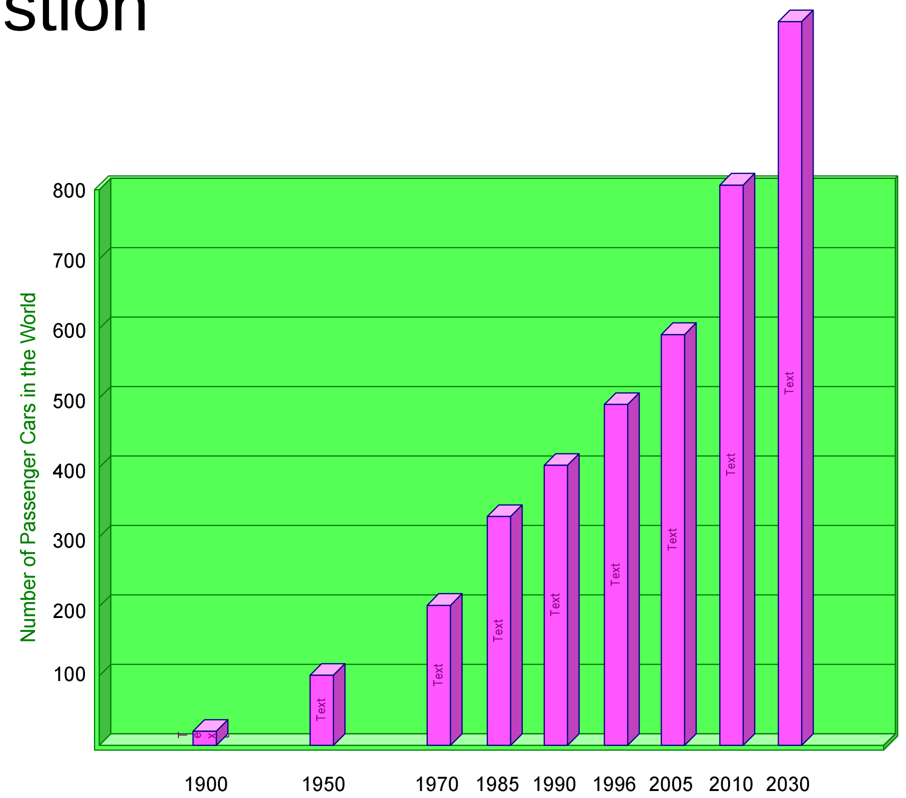
Premises

- Current traffic collection methods have focused on the **inevitable**.
- New systems, such as mobile phone tracking, will focus on integrating **predictive** traffic data into the mix of information provided in navigation system databases.
- **RDS-TMC** message broadcasting has proved surprisingly robust. However, message size and pre-coding of locations have always been troublesome, and are proving to be obstacles to expanding both quantity and quality of data delivery.
- Improved data collection methods will require improvements in the way traffic information is delivered.
- New methods are emerging for referencing the locations of incidents and for coding traffic and other information methods.

Same place; different time.
It's like this every weeknight in Moscow

The Roots of Traffic Congestion

- The number of cars in the world doubled to 200 million from 1950 to 1970, and doubled again in the next twenty years.
- Sales are expected to level off in Europé, but sales in China (25% increase 2005-2006), India (18%) and Southeast Asia are exptected to grow.
- China is building new roads at a breakneck pace (40,000 km added between 1995 and 2007)--just like the US did in the 1950s and ’60s, and Europé did in the 1960s and ’70s.



The Growth of Worldwide Passenger Cars in Operation (Units along y axis are in millions)

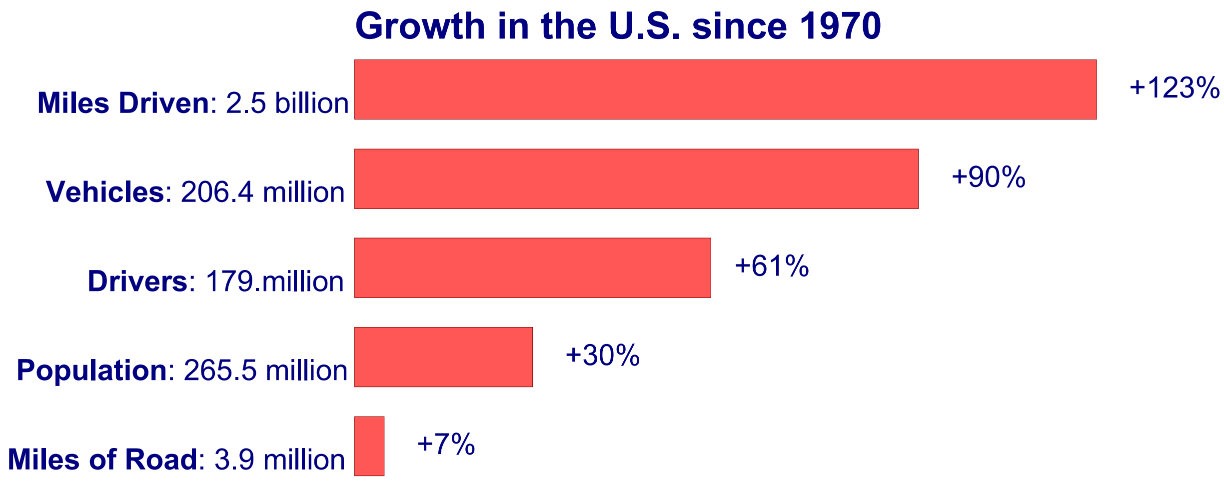
Average Time Spent in Vehicles (h/year)		
	USA	Europe
Total:	541	274
As Driver:	340	183
As Passenger:	201	91

(Source: Roland Berger analysis 2000)

The Roots of Traffic Congestion

- There are too many of these great inventions driving longer distances on proportionately fewer kilometres of roads.
- The real question is Why has this explosive growth in car ownership and driving occurred?
- Population growth is not the only explanation; mostly just poor planning

Growth in U.S. automobile usage 1970 - 1996



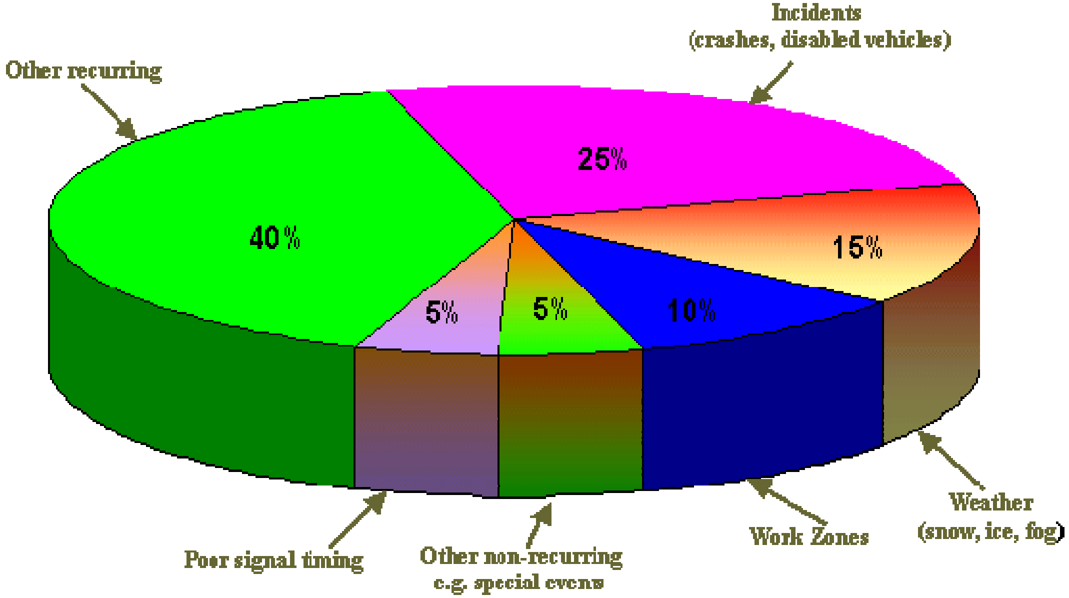
Source: U.S. Federal Highway Administration (1998)

…by the way, I realise this is all good news for the industries selling cars and trucks

The Roots of Traffic Congestion

- The Predictable events comprise 60% of the reasons for traffic congestion
  - Work Zones
  - Poor Signal Timing
  - Other recurring
  - Other non-recurring
- The Inevitable events comprise the remaining 40%
  - Weather
  - Incidents

Reasons for Traffic Congestion



Source: U.S. Federal Highway Administration, Office of Operations (2000)

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Traffic Information Provision

Main Aspects of Traffic Information Provision

- Traffic information delivery today in Europe is almost exclusively **based on the RDS-TMC** method, both for audio delivery over radio networks and for data delivery to special-purpose traffic information systems and integrated navigation systems.
- **TMC Services are expanding into other countries**, and are now also in place in America; they will launch during 2007 in Australia; they have been demonstrated in China; and, they are under development for a number of other countries.
- **TPEG will replace RDS-TMC** within the coming five years as digital radio systems (T-DAB, SDRS, HD-Radio) replace FM radios in vehicles.
- Traveller Information Services Organisation **(TISA)** first meeting in Berlin (Nov 21).

Transport Protocol Expert Group

- TPEG Forum

The TPEG Forum manages the standardisation activities for TPEG.

Developments occurring in other parts of the world outside of Europe (e.g., Korea) are incorporated into the standardisation activities through the TPEG Forum.

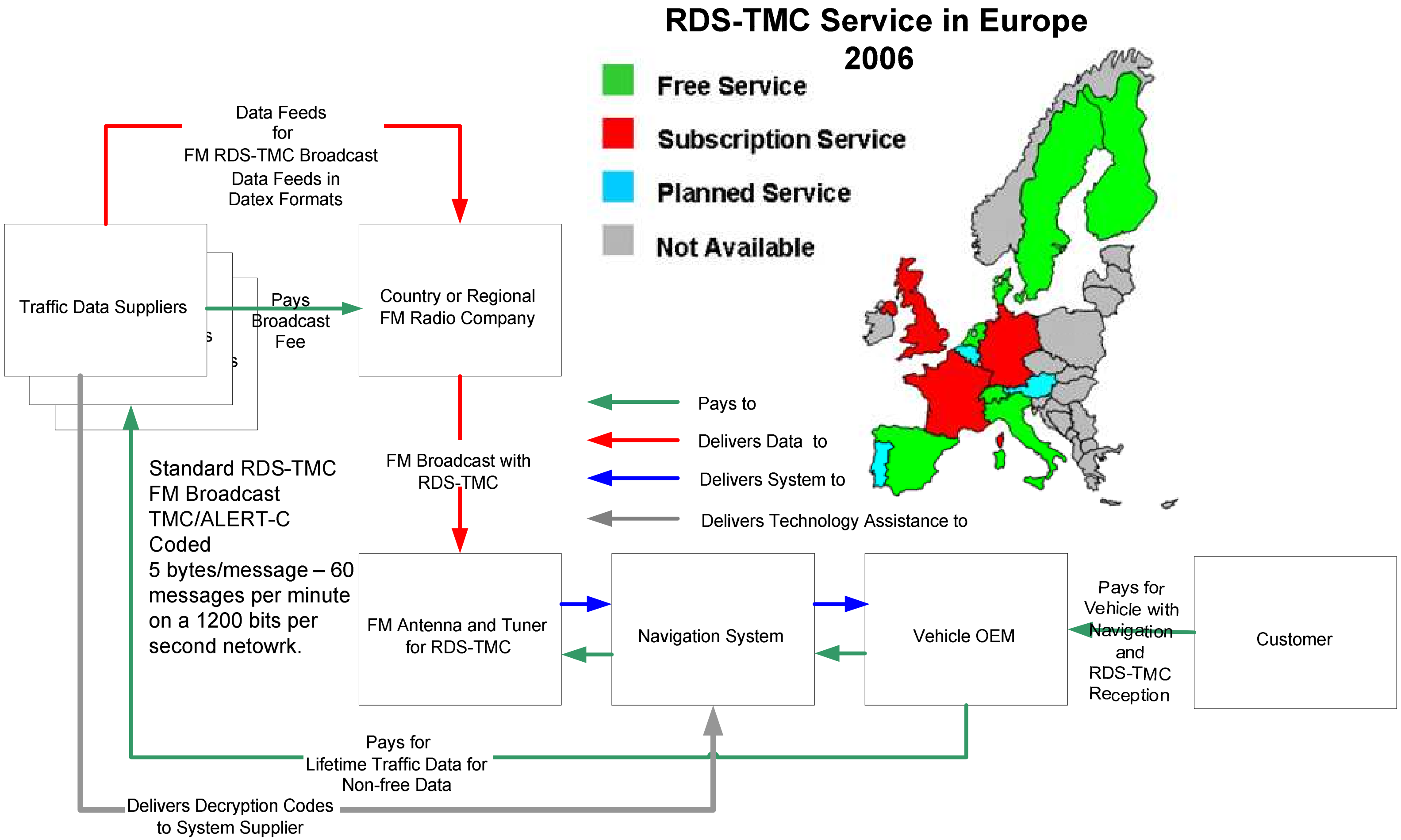
- Status of standardisation

TPEG Binary and TPEG XML are now official CEN/ISO standards

- Direction

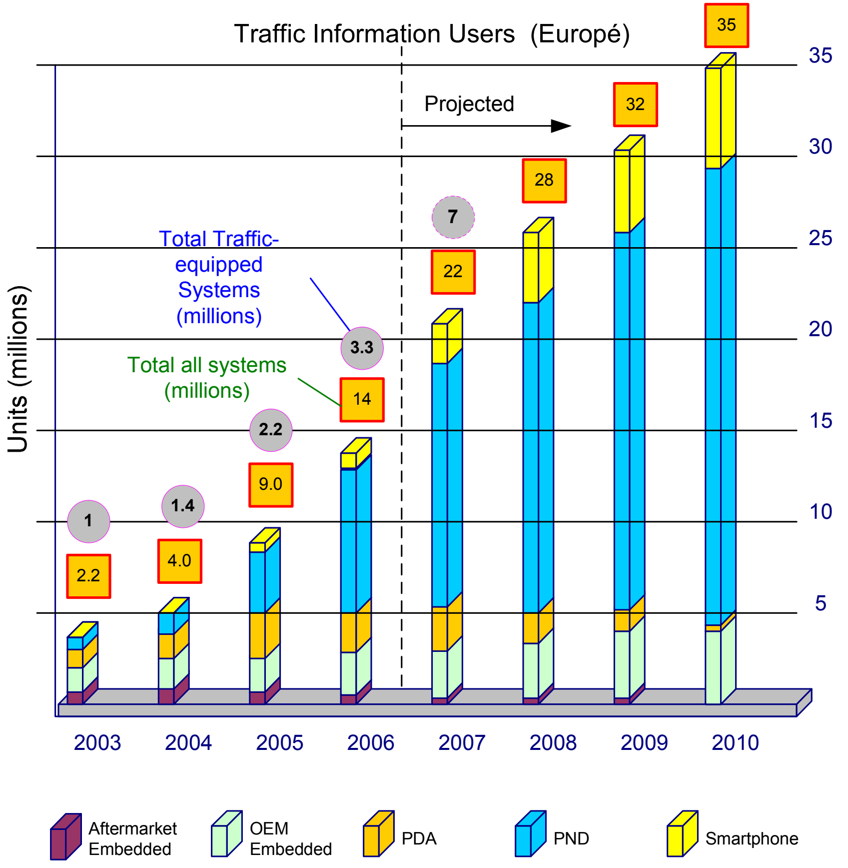
TMC Forum and TPEG Forum jointly formed the Road Transport Information Group and are now joining forces in TISA.

Traffic Information in Europe



Traffic Information Data Delivery

- Most of the users of traffic information in Europe today receive the information **via an integrated route guidance system** that is equipped with an integrated FM antenna and are delivered with the location tables for the free service areas and selected location tables with the appropriate decryption software for the fee-based services.



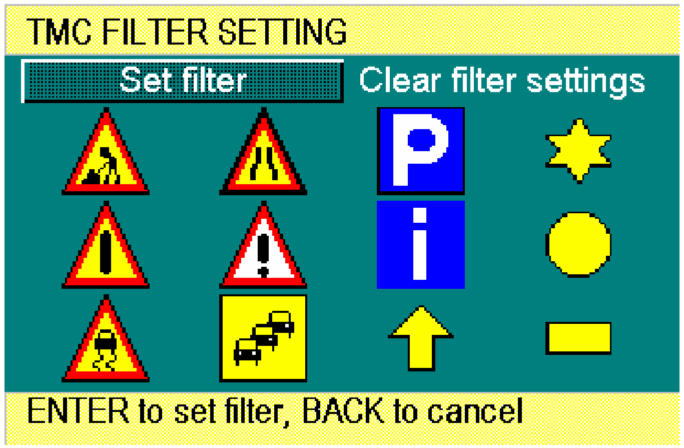
Sources: SBD; Navteq; GfK; Michael L. Sena Consulting AB

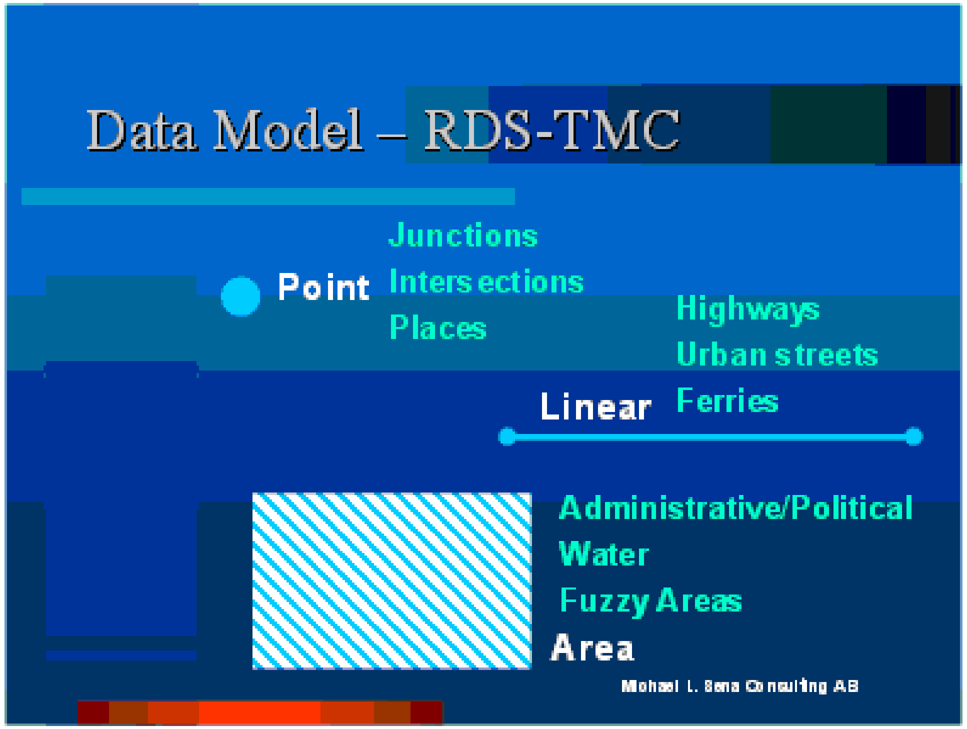
Traffic Information Data Delivery

- The costs for the **fee-based systems** are pre-paid by either the navigation system supplier or the OEM into whose vehicles the systems are installed.
- By my estimates, there are **approximately 3 million users of RDS-TMC** traffic information receivers in vehicles in 2006. Added to this, there are an estimated 200,000 – 300,000 users of special-purpose traffic information devices from companies like Trafficmaster and Mediamobile.

Radio Data System-Traffic Message Channel

- A brilliantly simple technique for coding traffic messages in any language under the sun.
- It was originally designed as a way of transferring traffic information from traffic control centres to broadcasters.





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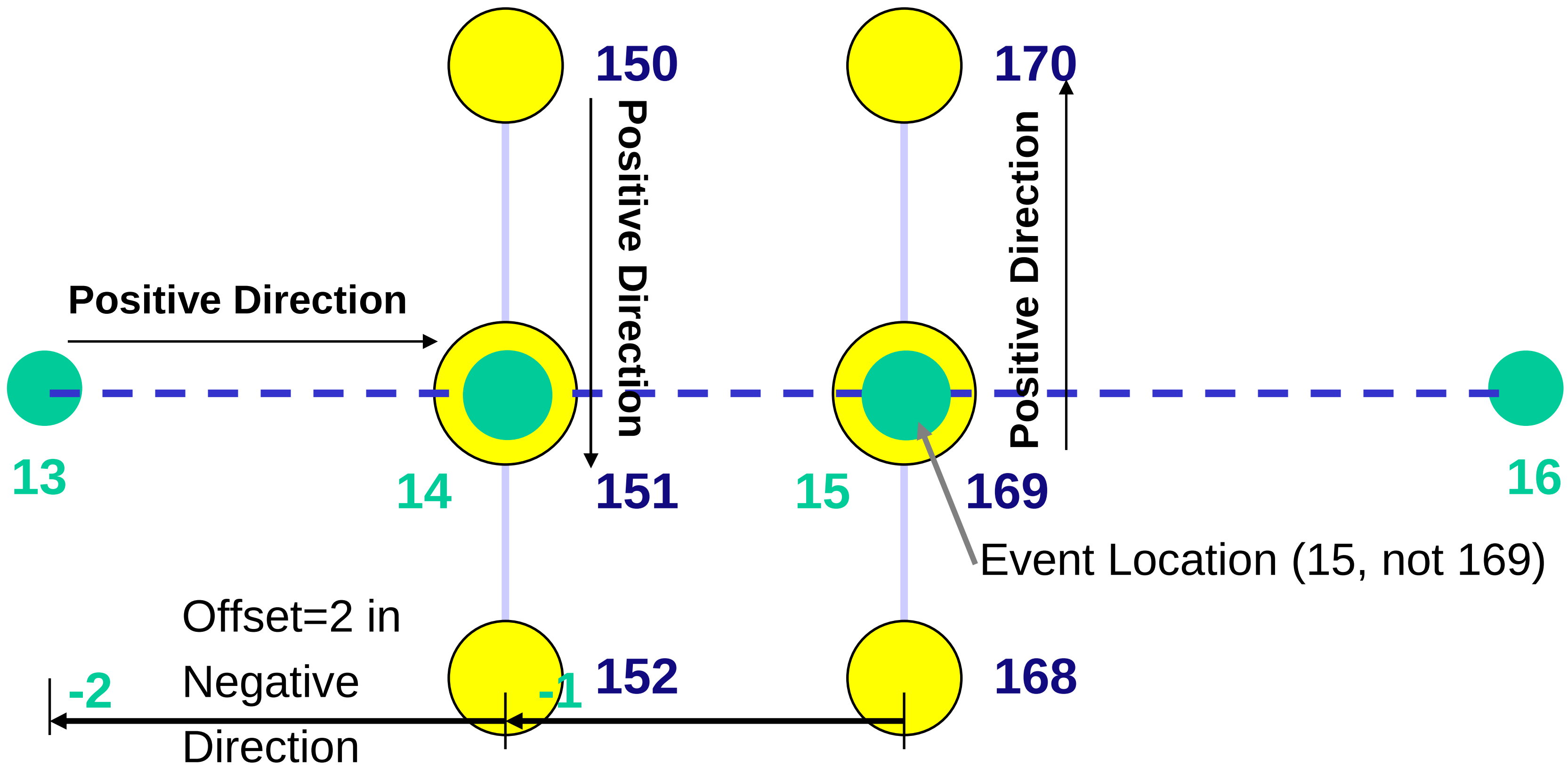
Radio Data System-Traffic Message Channel

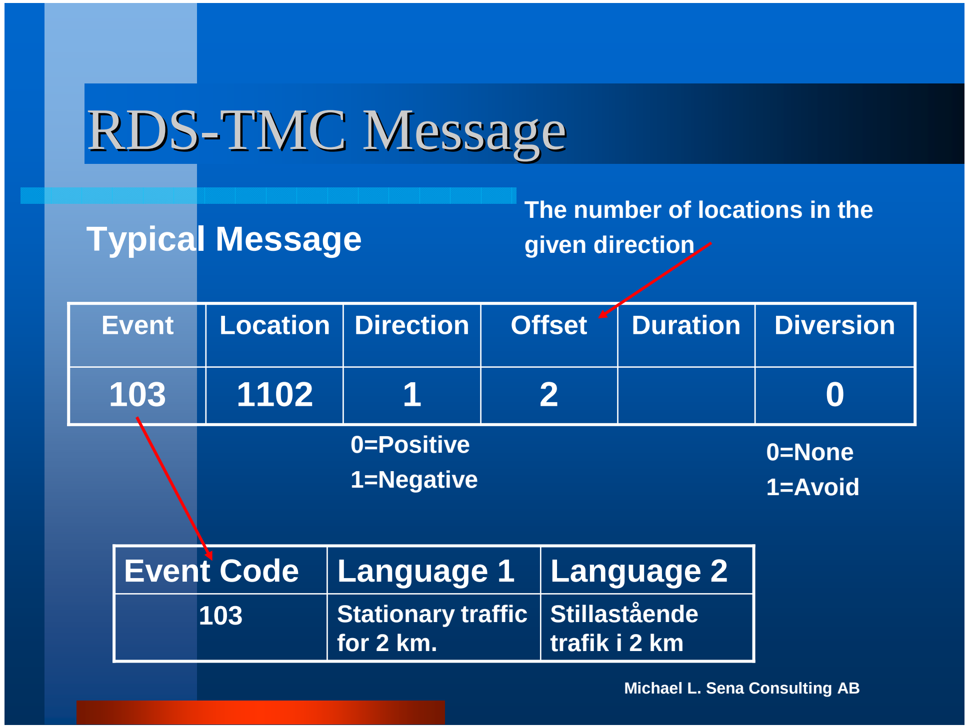


ALERT-C Location Code Table

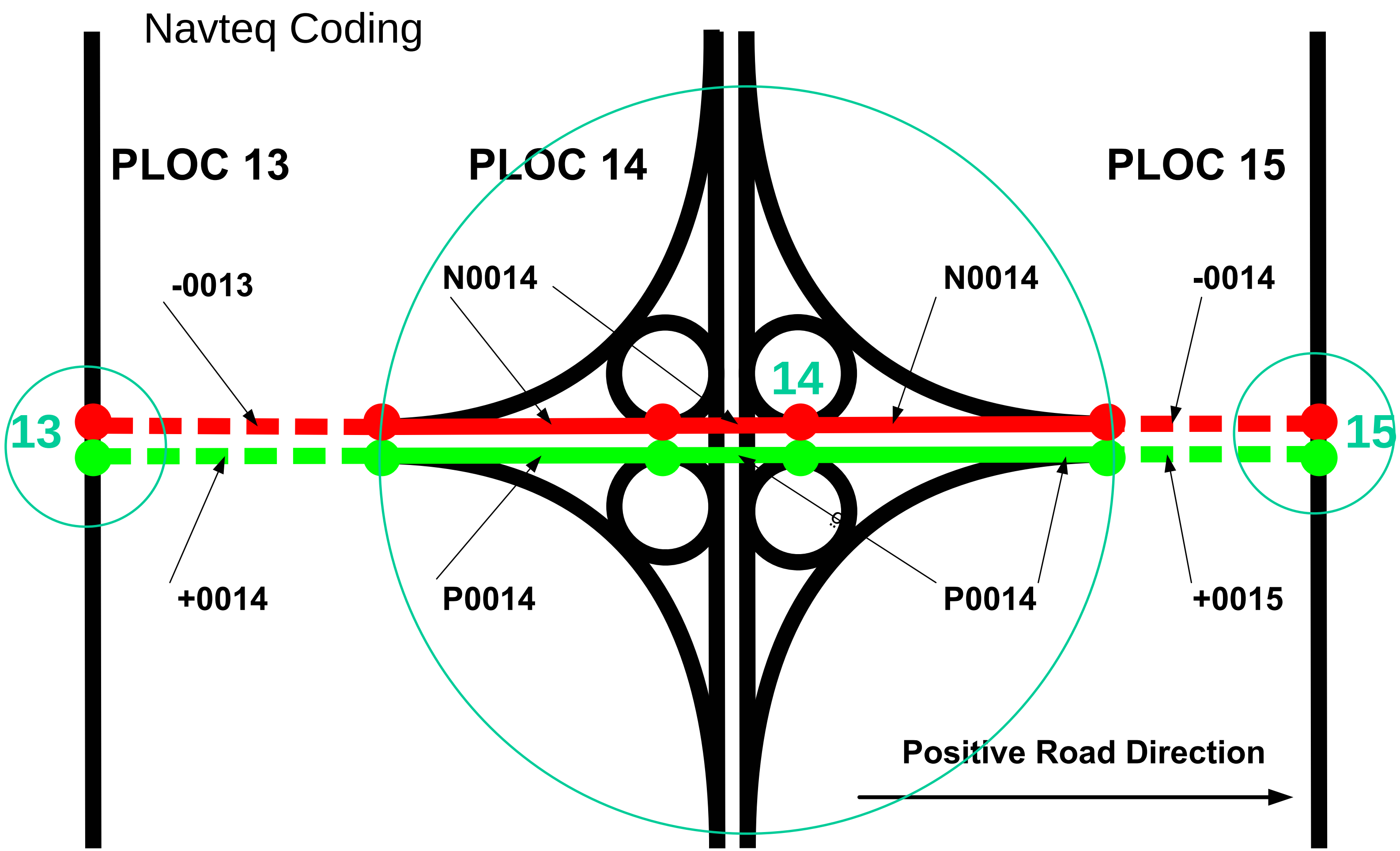
Location Code	Type	Road Number	First Name	Second Name	Ref A	Ref L	- offset	+ offset	Long/Lat
1100	P1.11	Rt A	Village X	Main St	10			1101	
1101	P3.34	Rt A	Town Hall H	Main St	10		1100	1102	
1102	P1.1	Rt A	Junction J	Main St	2001		1101	1103	
1103	P1.1	Rt A	Village Z	Main St	2001		1102		
55	P3.1	Rt B	Tunnel P		1110	756		56	
56	P1.1	Rt B	Junction J	Rt A	2001		55	57	
57	P3.2	Rt B	Bridge K		2001		56		
756	L1.1	Rt C	S-Town	t-Town	1110			757	
757	L1.1	Rt C	S-Town	u-Town	2001		756	758	
758	L1.1	Rt C	S-Town	v-Town	2001		757		
10	A.		Village X		2001				
1110	A.		Tunnel P		2001				
2000	A.		State S						
2001	A.		City Y		2000				

RDS-TMC Traffic Message

- An event is recorded using one of several thousand different event codes, each one describing a particular type of event, such as Code 103 meaning Stationary traffic for 2 km.
- Every location in a country's database is unique within a Location Code Table.
- Direction is related to the coding of the database, not compass or direction of traffic.
- Duration is a subjective estimate made by the traffic controller.



Navigable Database Coding



RDS-TMC Services in Europe

Country	Public Provider	Free	Commercial Provider	Fee
Austria	Road Administration	√		
Belgium				
Flanders (North)	Flanders Road Admiin	√		
Walloon (South)	TMC4U	√		
Czech Republic	Planned - Road Admin	(√)		
Denmark	Road Administration	√		
Finland	Road Administration	√		
France	Motorway Operators	√	Mediamobile	√
Germany	Public Radio Stations	√	T-Mobile Traffic	√
Hungary	Planned - Road Admin	(√)		
Republic of Ireland	Planned - Road Admin	(√)		
Italy	Road Administration	√	Cities - Mizar	√
Luxembourg	Planned - Road Admin	(√)		
The Netherlands	Road Administration	√		
Norway	Road Administration	√		
Portugal	Planned - Road Admin	(√)		

RDS-TMC Services in Europe

Country	Public Provider	Free	Commercial Provider	Fee
Spain	Road Administration	√		
Sweden	Road Administration	√		
Switzerland	Road Administration	√		
The UK				
England			iTMC (ITIS) Trafficmaster	√ √
Wales			iTMC (ITIS) Trafficmaster	√ √
Scotland			iTMC (ITIS) Trafficmaster	√ √
Northern Ireland			iTMC (ITIS) Trafficmaster	√ √

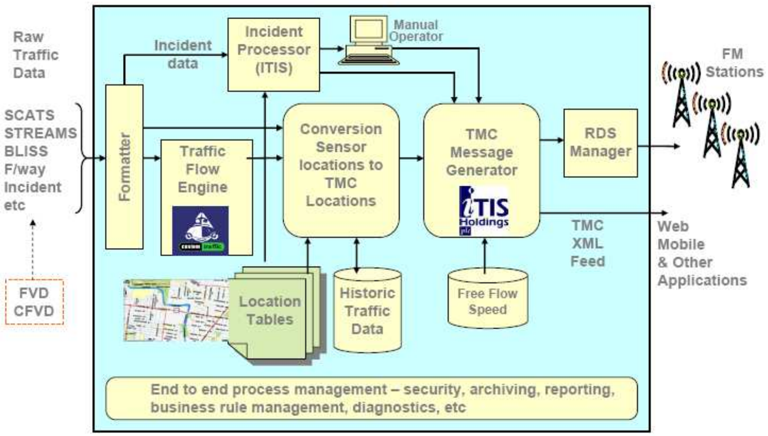
Other Services in Europe

Country	Public Provider	Free	Commercial Provider	Fee
Austria			ÖAMTC – ERIC2000/3000	Members of ÖAMTC
Belgium				
Flanders (North)			TCB – ERIC2000/3000	Members of TCB
Walloon (South)			TCB – ERIC2000/3000	Members of TCB
France			Foreign members of ARC clubs	Members of ACR Clubs
Germany			ADAC – ERIC2000/3000	Members of ADAC
Italy			ACI – ERIC 2000/3000 TargaInfomobility and Trafficmaster Joint Venture	Members of ACI Fiat car brands with bConnect Service
The UK				
England and partial Wales, Scotland and N. Ireland			Trafficmaster and RAC	RAC Members or buyers of Trafficmaster equipment or owners of cars equipped with trafficmaster equipment

Traffic Information Provision Outside Europe

- North America
- China
- Korea
- Australia

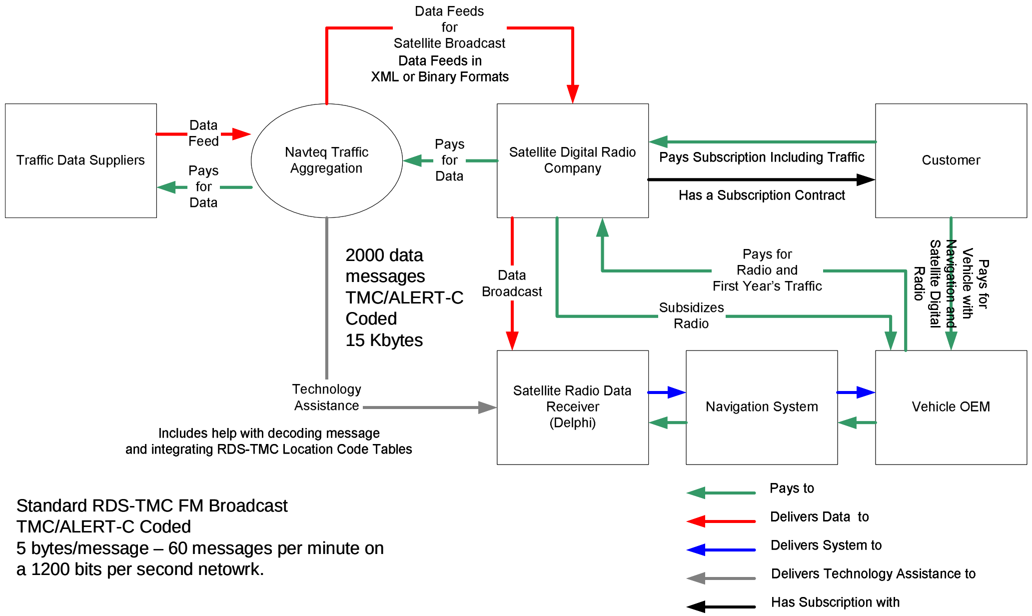
Intelematics Traffic Operations Hub (TOH) – block diag



The Data Delivery Model in the U.S.

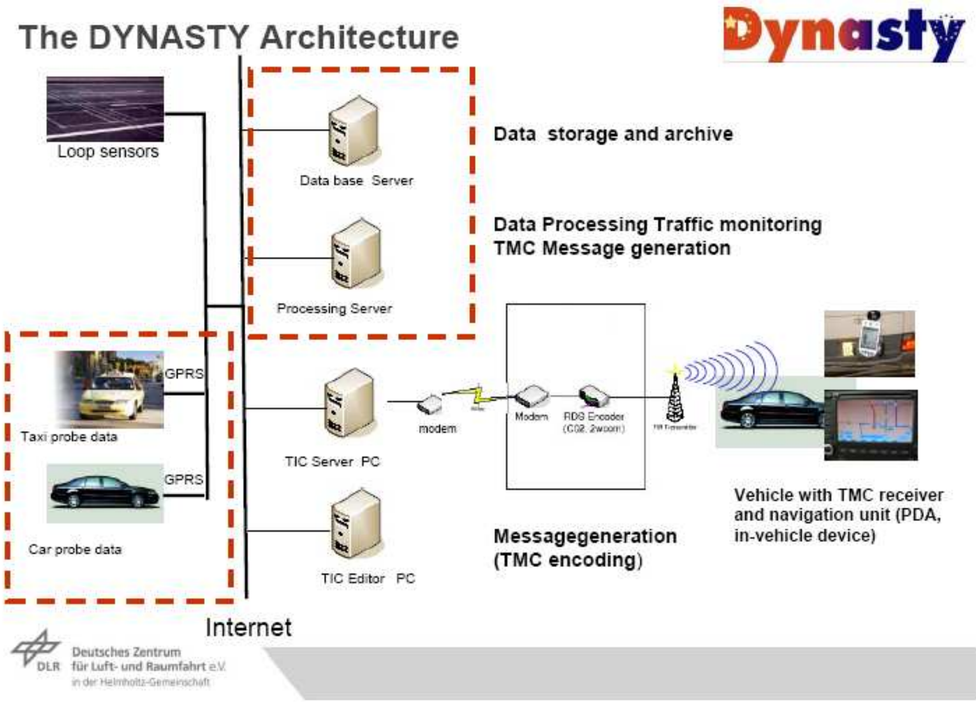
Dynamic Traffic Information Process Flow in U.S. Market: Navteq Traffic

16 May 2006



Dynasty: RDS-TMC in China

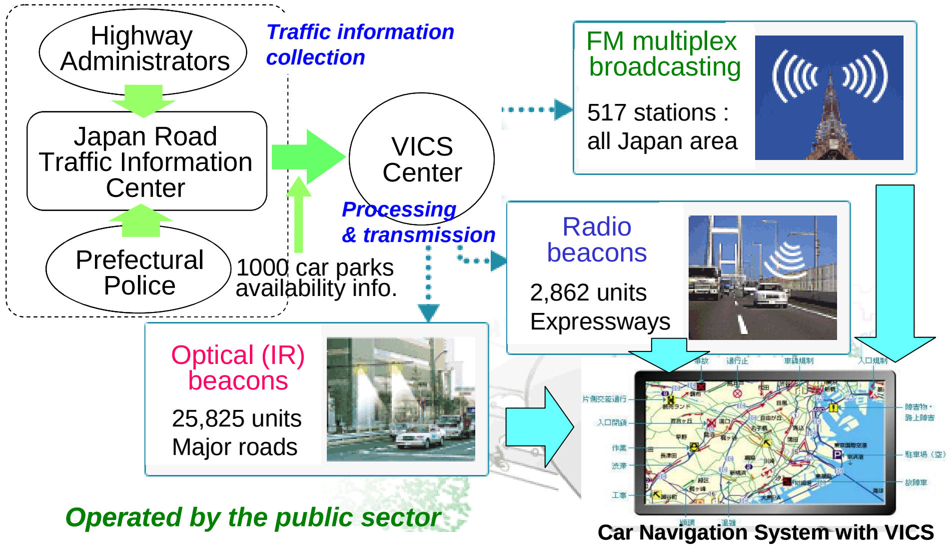
- Demonstration of the first TMC service for China
- EU project coordinated by ERTICO
- Real-time test of the whole TMC chain with approximately 250 locations in Beijing.
- Taxis served as probe sensors for data collection and message generation was based on floating car data
- TMC messages were broadcast from the CCTV Tower building
- TMC messages were used for in-vehicle navigation.



VICS in Japan

- VICS, for Vehicle Information and Communication System, employs information collection techniques that are similar to those used in RDS-TMC.
- All of the navigation systems in the country use the coding scheme created by JDRMA.
- The Japan Road Traffic Information Center applies the traffic information to this database and delivers the information to vehicles equipped with VICS-enabled systems via radio beacons, infrared beacons and FM multiplex broadcast techniques.

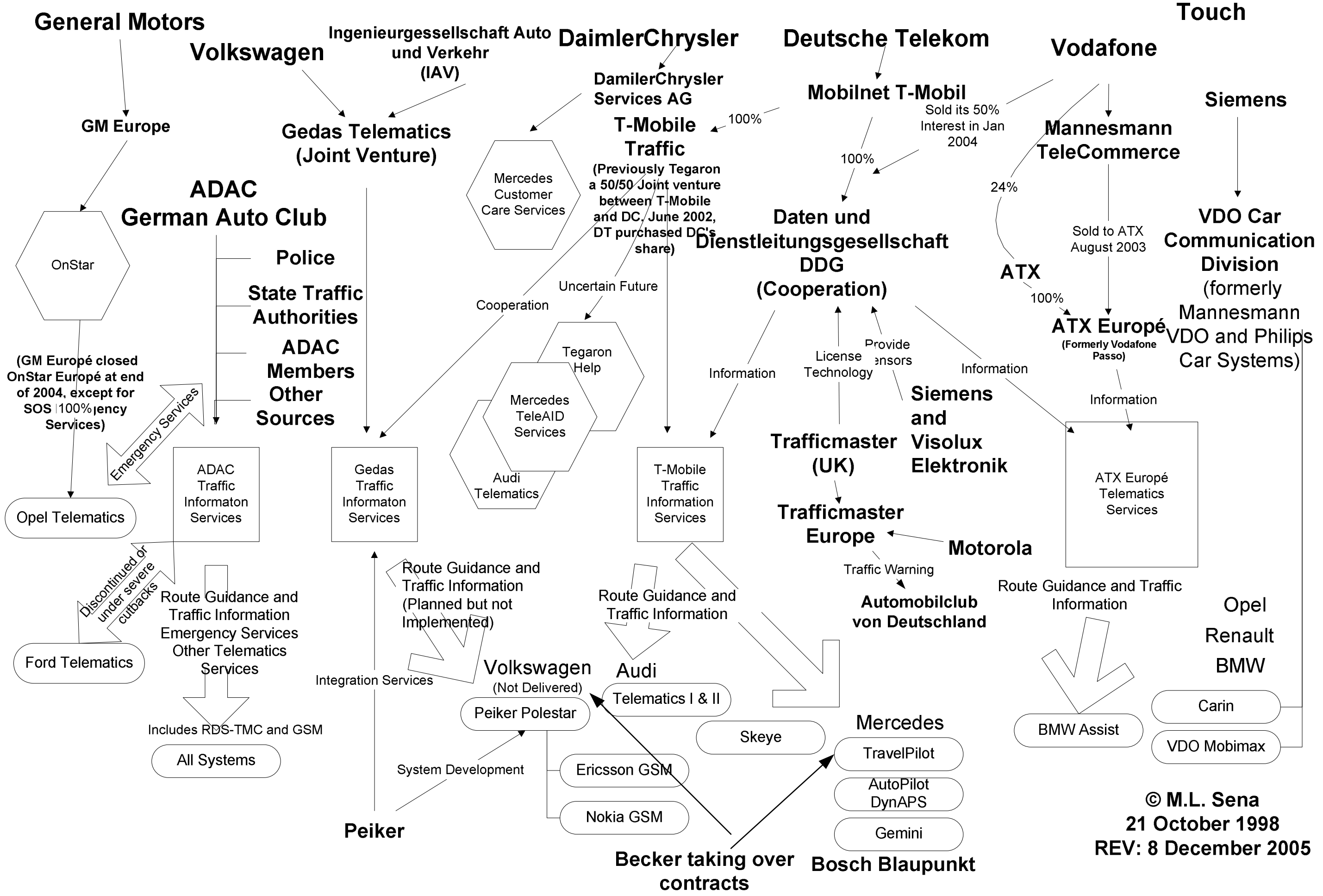
VICS (Vehicle Information Communication System) Since 1996



Real-time information (every 5 min.) such as traffic congestion, accidents, traffic regulations is displayed on a VICS car navigation system.

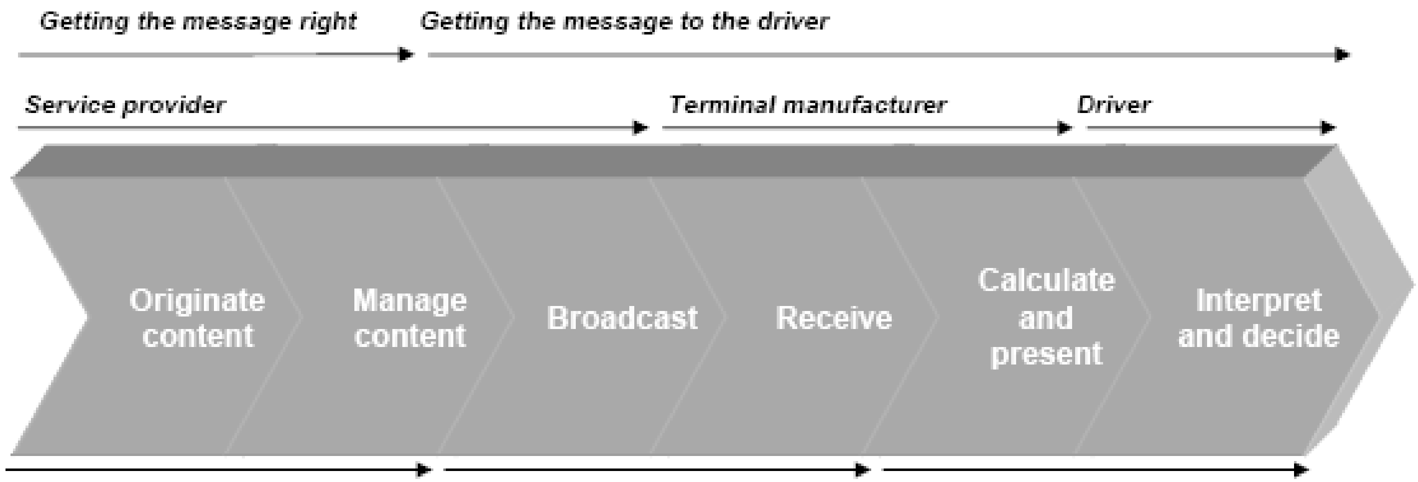
The traffic data is processed using a national map database originally created by the Japan Digital Road Map Association (JDRMA).

The Telematics Business in Germany



Traffic Information Delivery
How we view the process today

Process



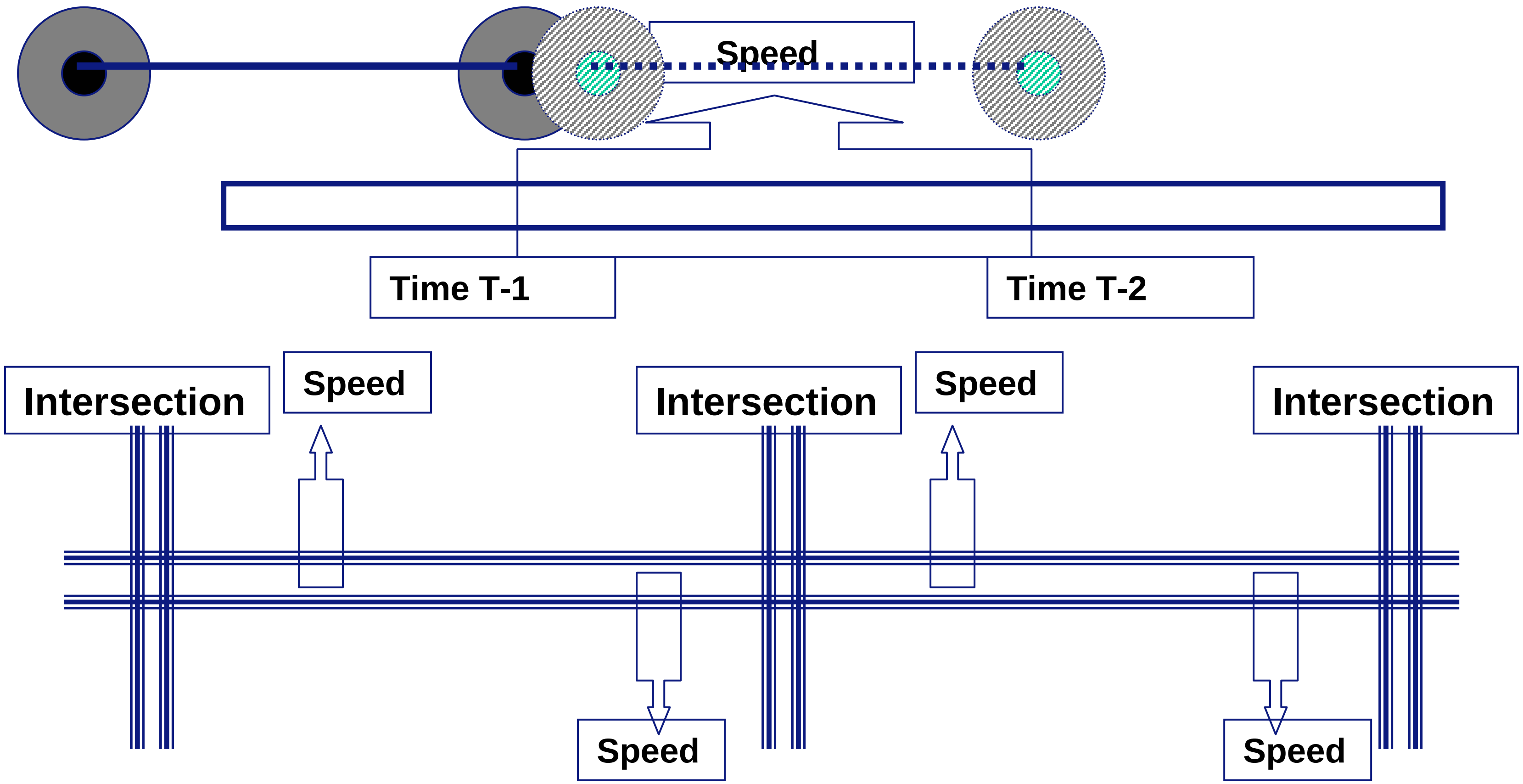
Technical challenges today	*•Availability of source data* *•Limitations of location table*	*•Limitations on bandwidth* *•FM Reception on Personal Navigation Devices*	*•Inconsistent treatment of messages between platforms* *•Event based Alert C messages*
Way forward	*•Wider use of flow data* *•"On the fly" location referencing*	*•Digital bearers*	*•Service Receiver Harmonisation group* *•Traffic Event Compact*

Market	Degree of Importance	
	Qualitative Data	*Quantitative Data*
Broadcast	Very High	Low
511-IVR	Moderate	Moderate
Dynamic Navigation	Low	Very High

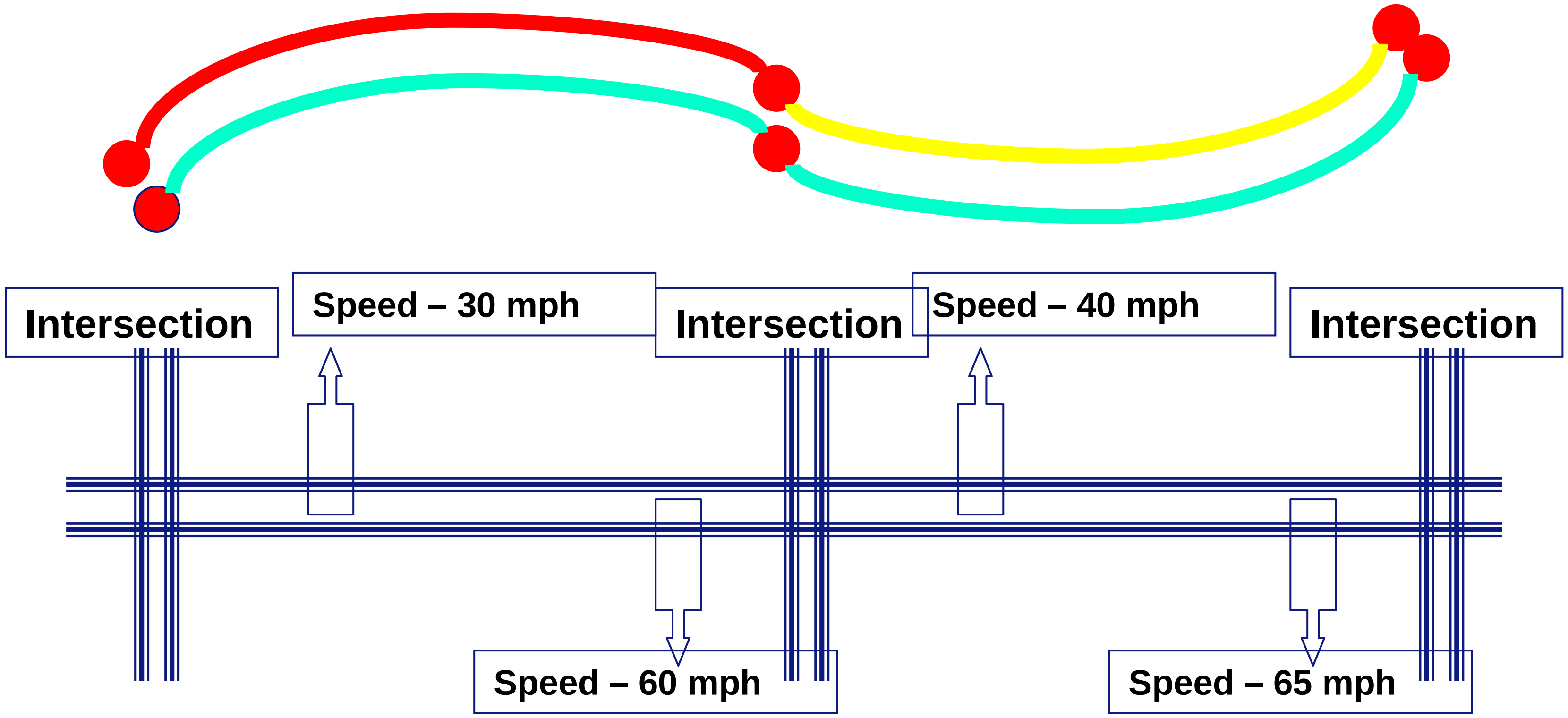
Principal Traffic Information Collection Methods

Technique	Broadcast	Verbal	Navigation
Sensor			
Optical	Process to event	Convert to speed	Convert to impediment
Loop	Process to event	Convert to speed	Convert to impediment
Probe			
Vehicle	Process to road and then to event	Road to speed	Road to speed to impediment
Cellular	Process to road and then to event	Road to speed	Road to speed to impediment
Observe			
Earth	Manually convert to event	Not applicable	Convert from observation to impediment
Aerial	Manually convert to event	Probably not applicable	Convert from observation to impediment

Flow-based Methods
Loop Detectors



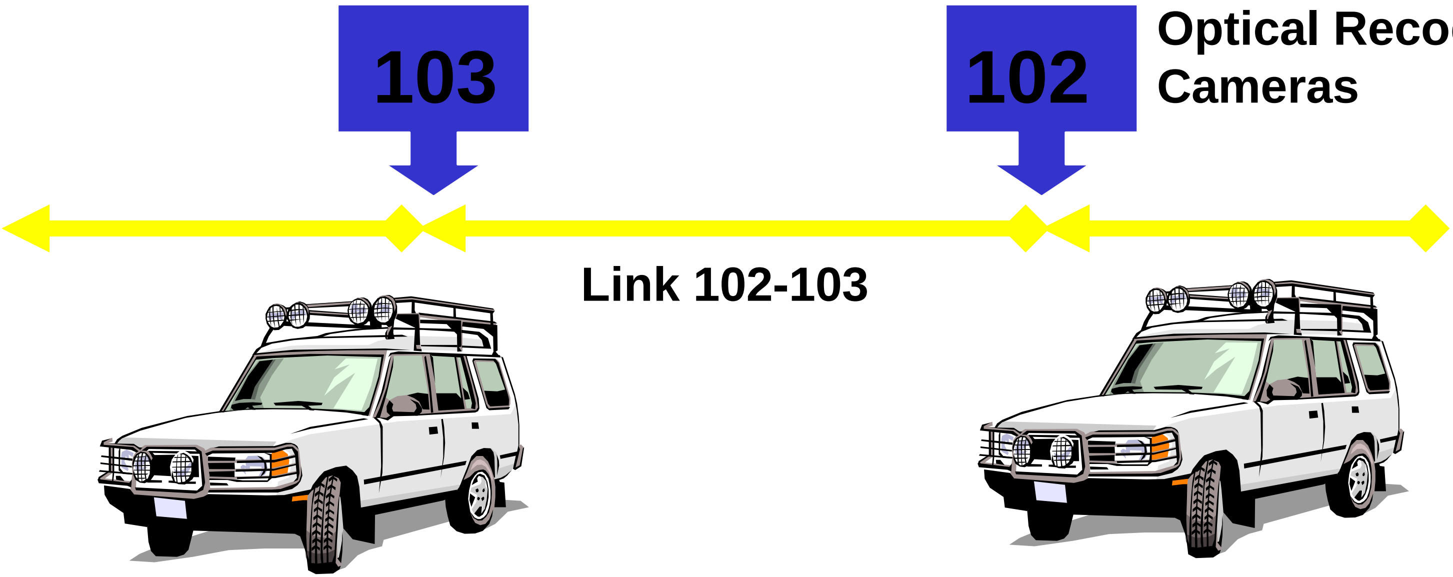
Flow-based Methods
Loop Detectors



Flow-based Methods

Optical Sensors

Optical Recognition Cameras

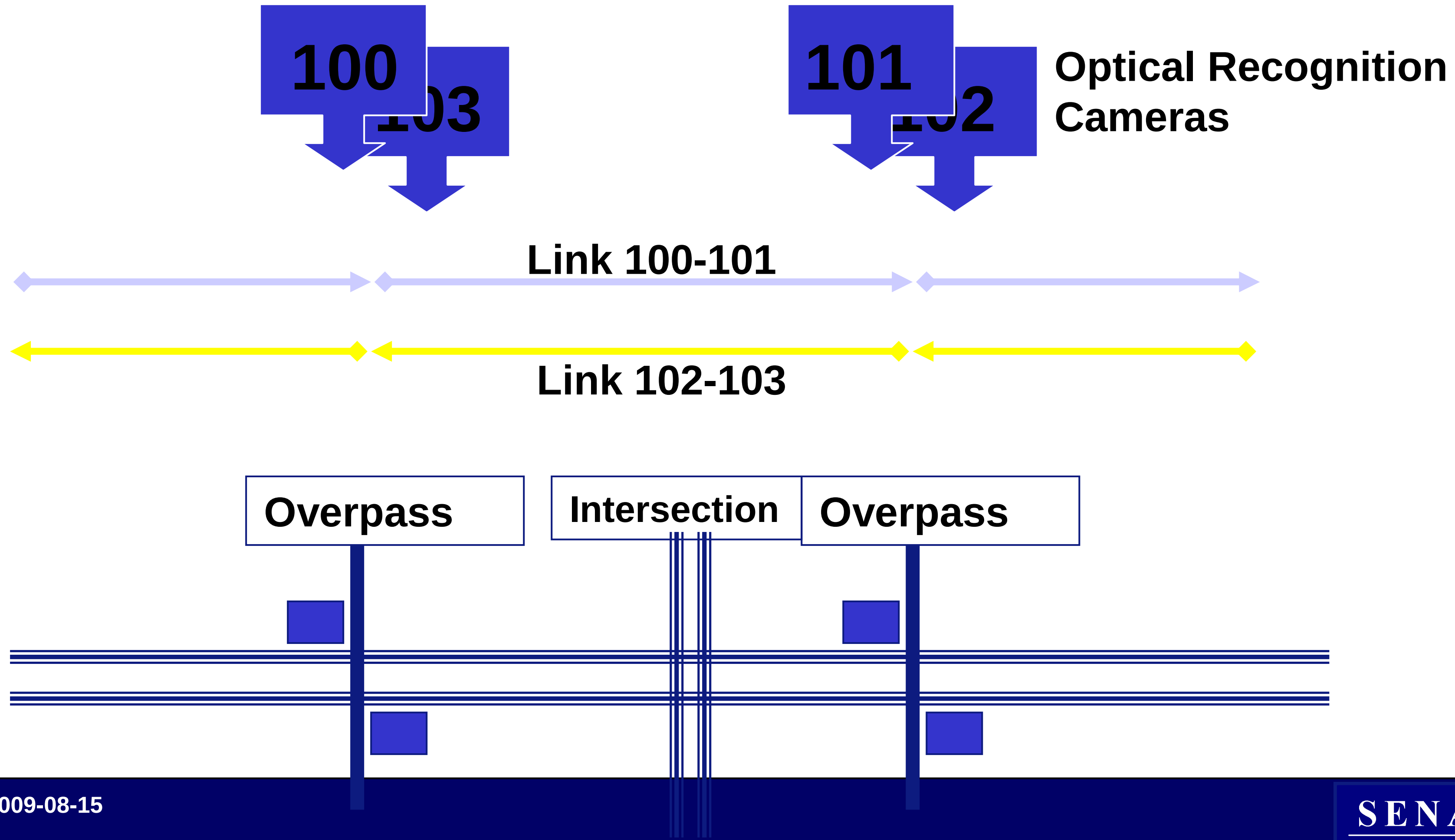


Same vehicle detected at Time T2

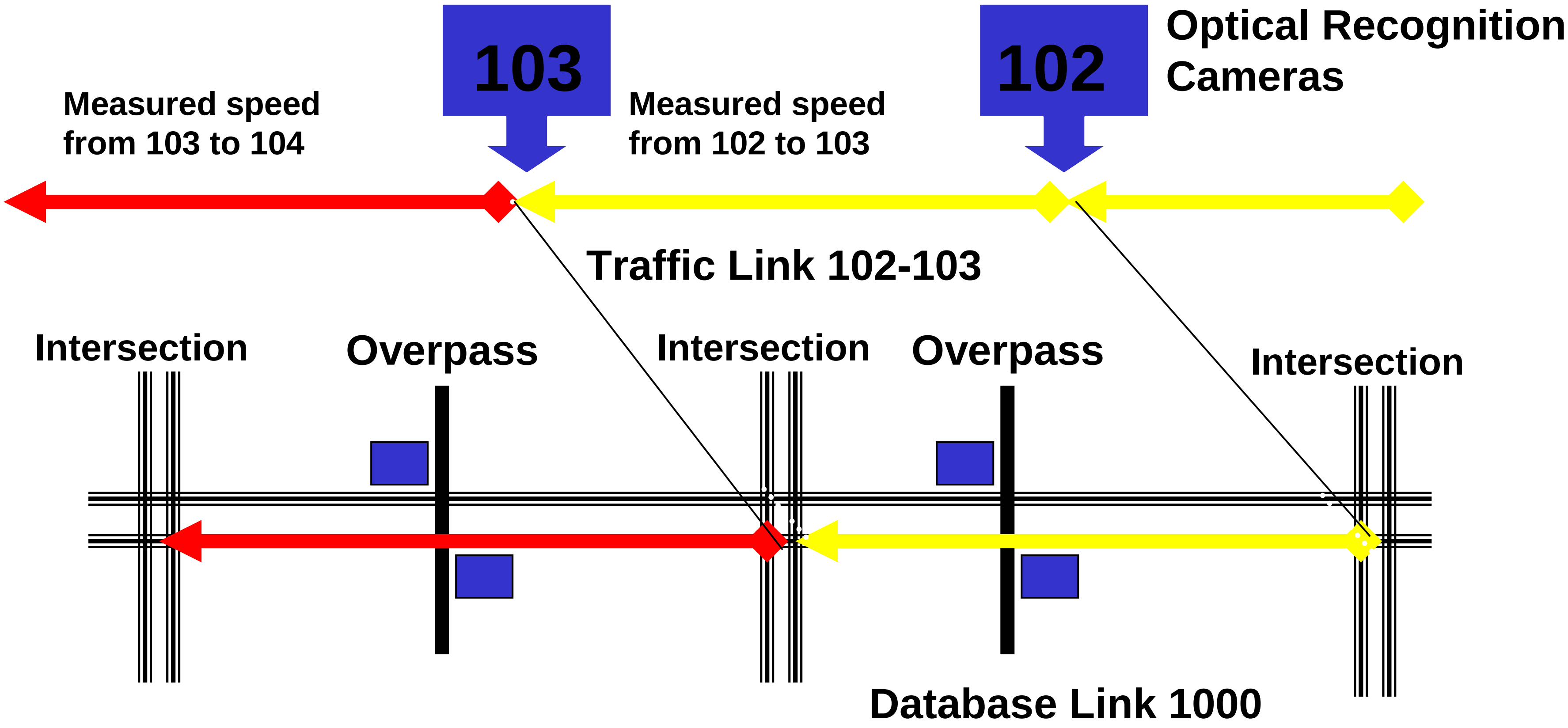
Vehicle detected at Time T1

Link 102-103 Average Travel Time = Distance (103-102) / Time (T2-T1)

Flow-based Methods
Optical Sensors



Data Model
Optical Sensors



Impedence Coding (example)

Event Code	Message	Added Impedence FC 1-2	Added Impedence FC 3-4
1	Traffic problem	1.25	2.0
101	Stationary Traffic	1.45	2.5
102	St. Traffic for 1 km	1.5	2.6
103	**St. Traffic for 2 km**	**2**	3.0
215	Accident(s) St. Traffic	1.45	2.5
571	Roadworks. Right lane closed	1.5	2.6

What needs fixing

The principal limitations today of most traffic information solutions in Europe (and most other places in the world) and **what is being done about it**:

- Lack of high quality traffic information: **Floating Vehicle Data**
- Difficulties of creating and maintaining location tables, and the inherent limitation of requiring that the tables are stored on reception devices: **TPEG and AGORA-C**
- Limited bandwidth available with RDS-TMC: **Digital Radio**
- Inconsistencies between platforms in the way messages are translated and used: **Standardisation of all messages types.**
- Limitation of pre-defined messages: **Use of Web services.**

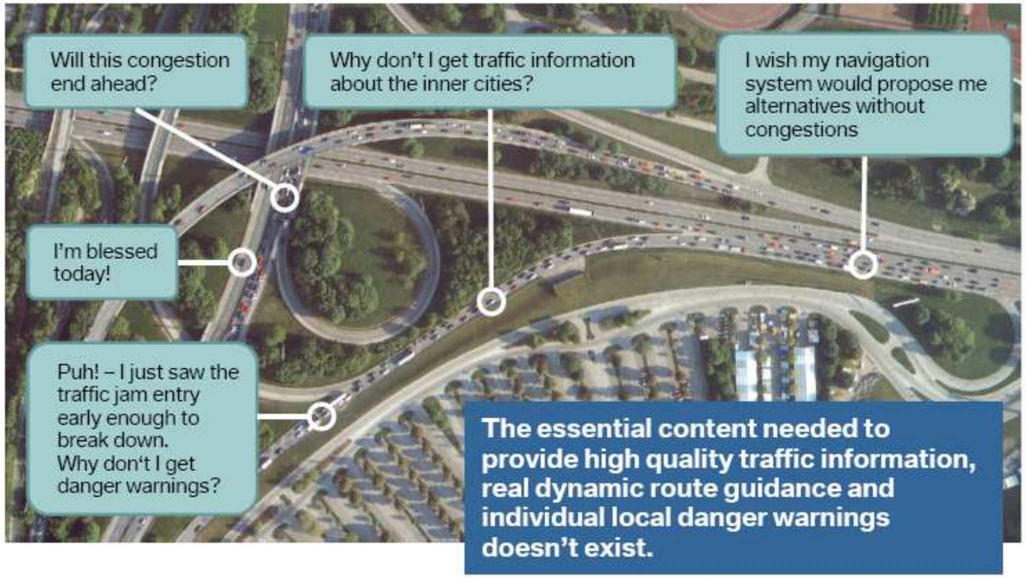


Illustration from presentation provided by BMW Group (10.11.2005) and delivered at the ITS World Congress 2005

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Pause

Europe

FCD, FVD or Probe

So-called “floating car data systems” offer a promising alternative to stationary traffic collection technologies, inductive loops, video-based and infrared-based systems. Floating car data systems have nothing to do with cars physically floating over the roadway. It is a rather ingenious term, invented by one of the transportation system intelligencia working on ways to reduce congestion without building new roads. The word **float** is Old English, *flotian*, meaning “body of water”.

There are many definitions of float, all more or less connected to doing something on or near water. The two definitions that best apply to the floating car application are:

•To move with a moving liquid: to drift; and,

•To pass from person to person, as in *The rumor floated through the town*.

•The word **float** is related to the word **fleet**, which is “a group of vessels or vehicles moving or working together”.

[1] Definitions for probe and float are from The World Book Encyclopedia Dictionary, Doubleday & Company, Inc., 1963.

FCD, FVD or Probe

The Floating Car Data (FCD) technique is based on a number of cars (in a fleet) being able to travel anywhere and deliver data from wherever they are. The cars are "floaters", and are equipped with positioning technology and wireless data communications. Depending on the technique used, the on-board systems send their speed of travel and/or their positions to a central server. The server collects travel time information from vehicles and matches the locations to digital maps. The result is a map of average speeds along segments of the road network.

Another term that is used for the same technique is Probe Data. **Probe** in the verb form means "to search into or examine thoroughly. As a noun, a **probe** is "an investigation", or it is "a vessel carrying scientific instruments to record or report back information about space or other planets—or even what is behind enemy lines". **Probe** is derived from the Latin, *proba*, "a proof", or *probare*, "prove".[1]

I believe that **Floating Vehicle Data** **(not just cars, but all types of vehicles)** is a more appropriate term for describing the technique of data collection, and that **Probe** is a good name for one of the vehicles working in the fleet.

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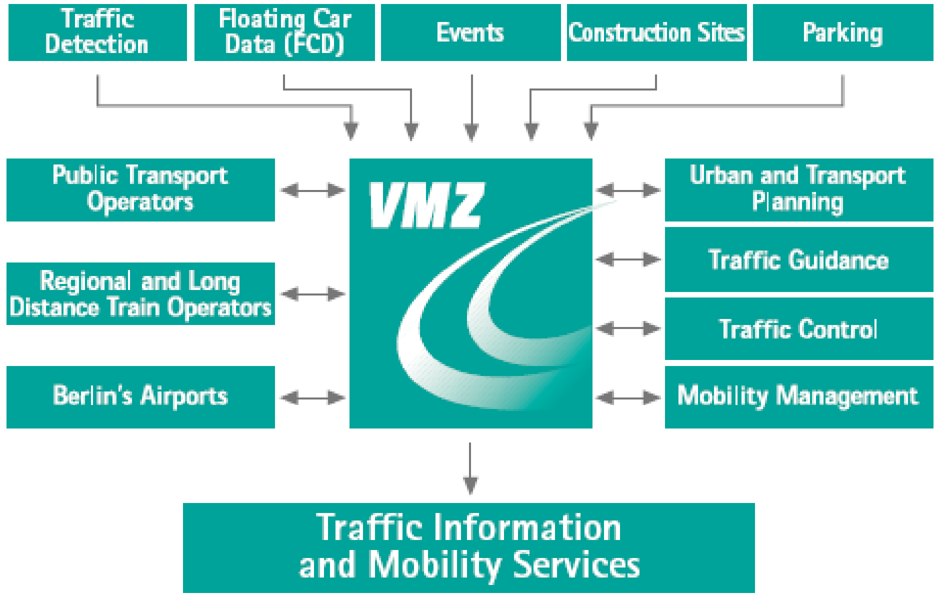
V-Traffic shown on a Navman personal navigation device

FCD, FVD or Probe

- Taxi-FCD developed by the German Aerospace Center (DLR)
- VMZ Berlin developed by DaimlerChrysler Services and Siemens
- OPTIS developed by Swedish group of companies led by the Swedish Road Administration.
- Mediamobile – France
- BMW Extended Floating Car Data – Germany
- T-Mobile (formerly Daten und Dienstleitungsgesellschaft DDG) – Germany
- Trafficmaster - UK
- ITIS – UK



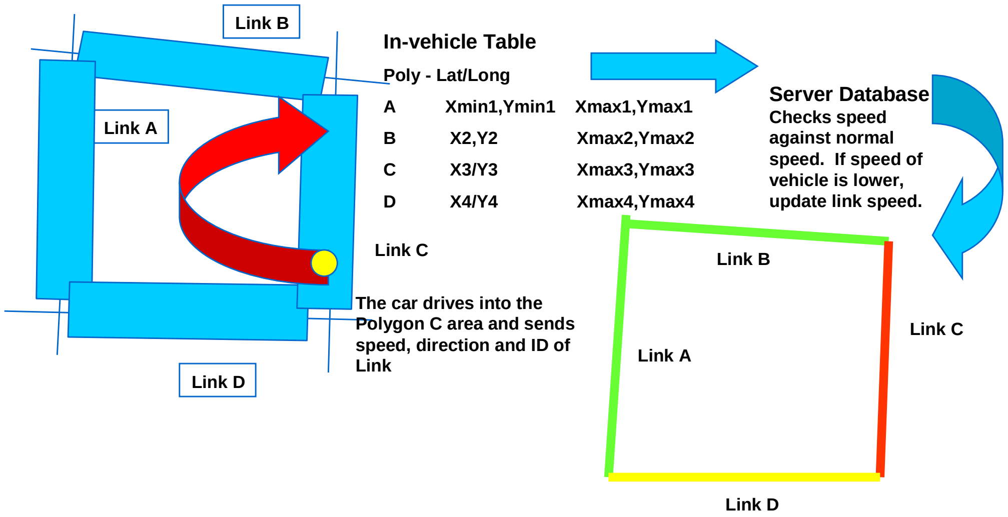
The objective of VMZ Berlin is to record and evaluate the traffic situation in Berlin.

V-Traffic shown on a an Alpine aftermarket system

Floating Vehicle Data

- This is the Trafficmaster approach.
- Each time a point is measured, the vehicle's speed is calculated.
- If the speed is lower than the speed listed in the on-board table, it is sent to the server for processing.
- If it is the same or higher, no data is sent.

Floating Car Data - Polygon



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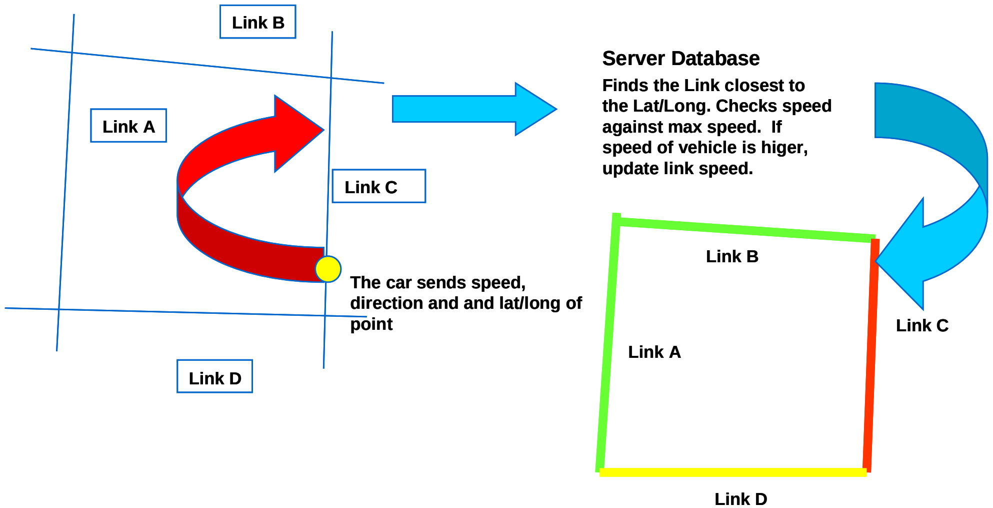
Floating Vehicle Data

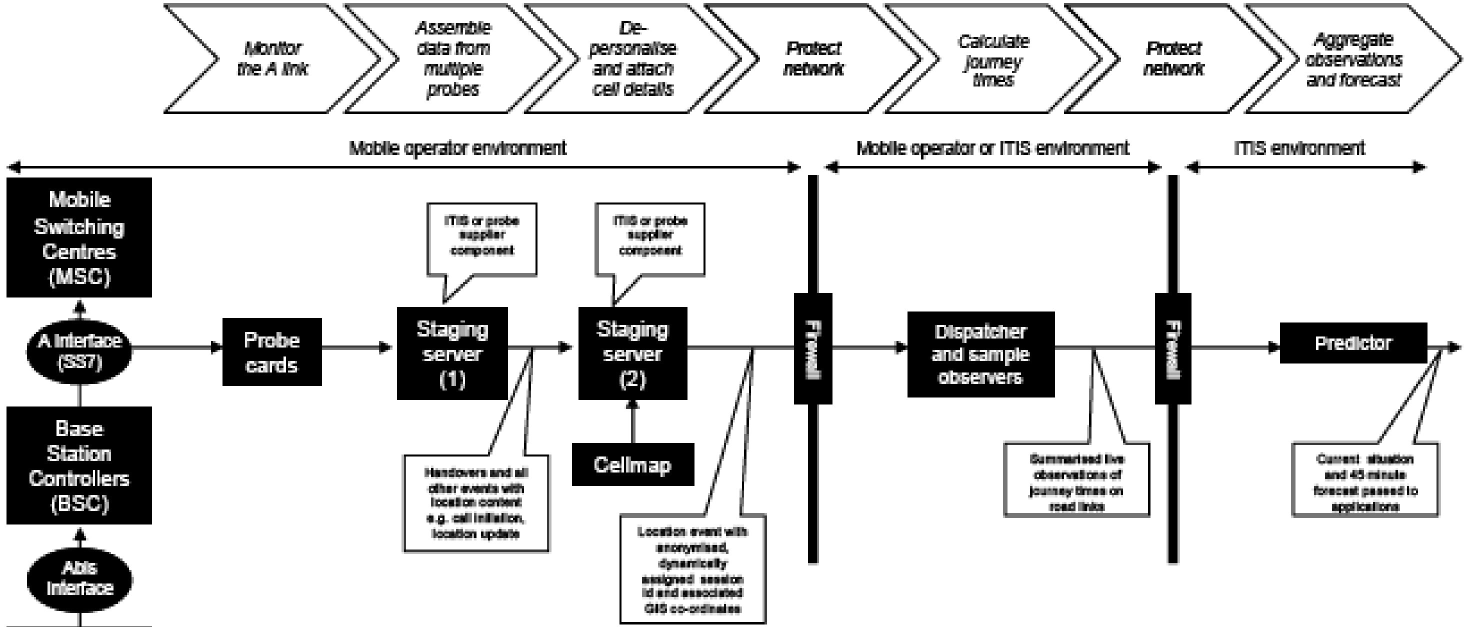
- This is the technique applied by DLR and ITIS.
- The in-vehicle system has no intelligence, and no data is stored on-board.
- The system sends data on a predetermined basis or when requested.
- The server calculates the speed along the most likely path of travel for the system.

Floating Car Data - No In-vehicle Data



The data sent includes the latitude and longitude of the positions collected by the system, a time stamp used to calculate speed, and possibly bearing angle.

Floating Cell Phone Data



Design objectives:

1. **Privacy.** Ensure that the personal details or whereabouts of a subscriber are never disclosed outside the operators' network.
2. **Security.** Prevent any access to the mobile operators' systems and customer information.
3. **Impact.** Passively monitor the mobile phone network and do not impact the load on network operations.

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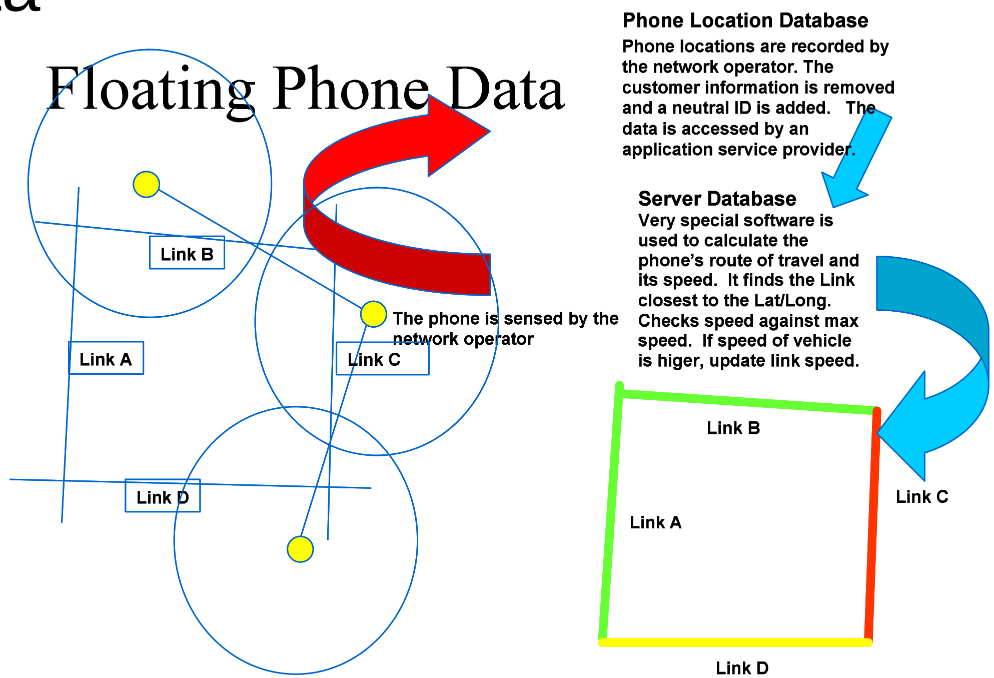
Floating Cell Phone Data

- This technique uses the mobile phone units inside vehicles as sensors to derive road traffic information.
- It relies on receiving signalling reports from the mobile network operators, which, thus far, has not been regulated by government bodies.
- The positional accuracy of this data is no higher than the distance between Base Station Transceiver Stations, which can be a few hundred metres in cities.



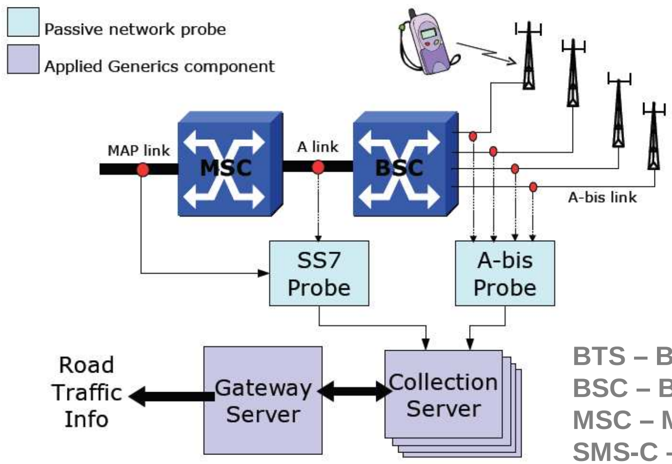
Typically, a mobile device generates a signalling report twice per second to enable the network operator to keep track of its own subscribers and the subscribers to other network who have roamed into their networks.

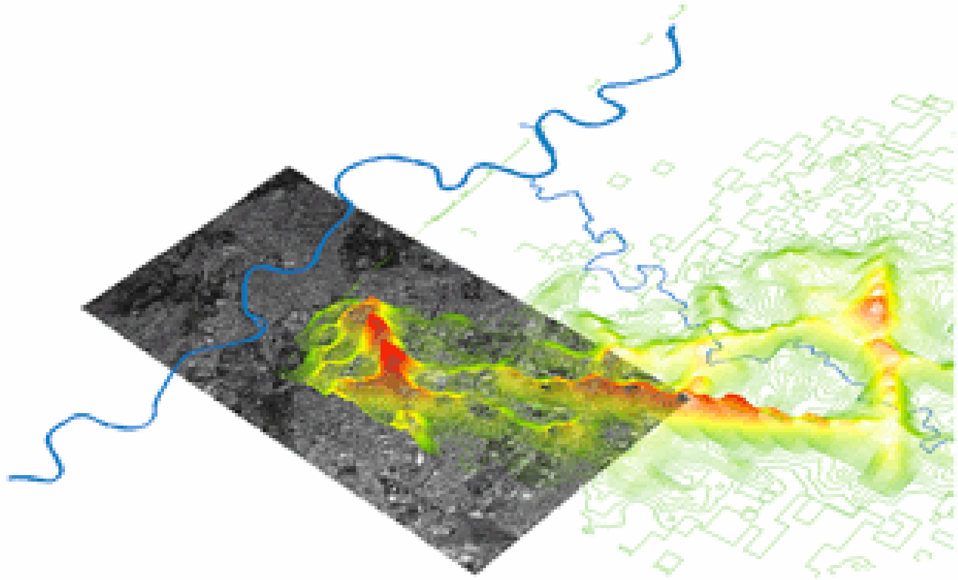
Mapping Mobile Phones

ITIS Holding's **Estimotion**

TomTom's **Applied Generics**

Applied Generics' RoDIN24





Real Time Rome

BTS – Base Station Transceiver Station
BSC – Base Station Controller
MSC – Mobile Switching Center
SMS-C – Short Message Service Center

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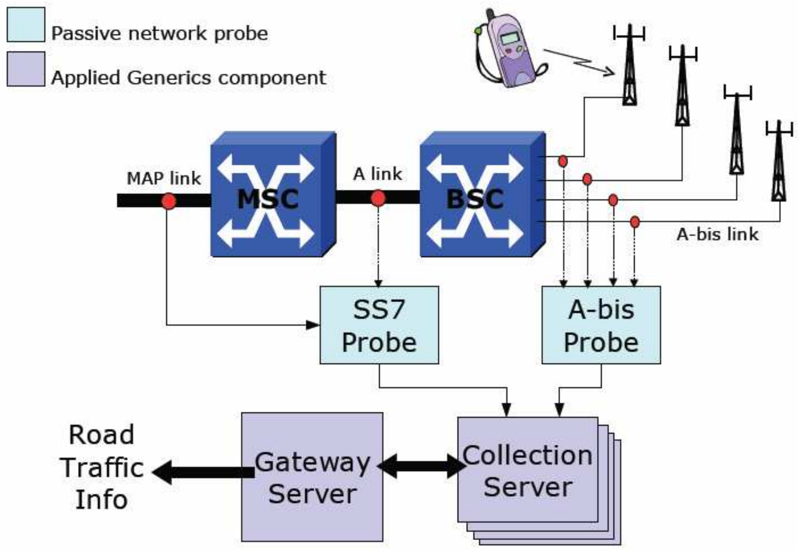
Research needed

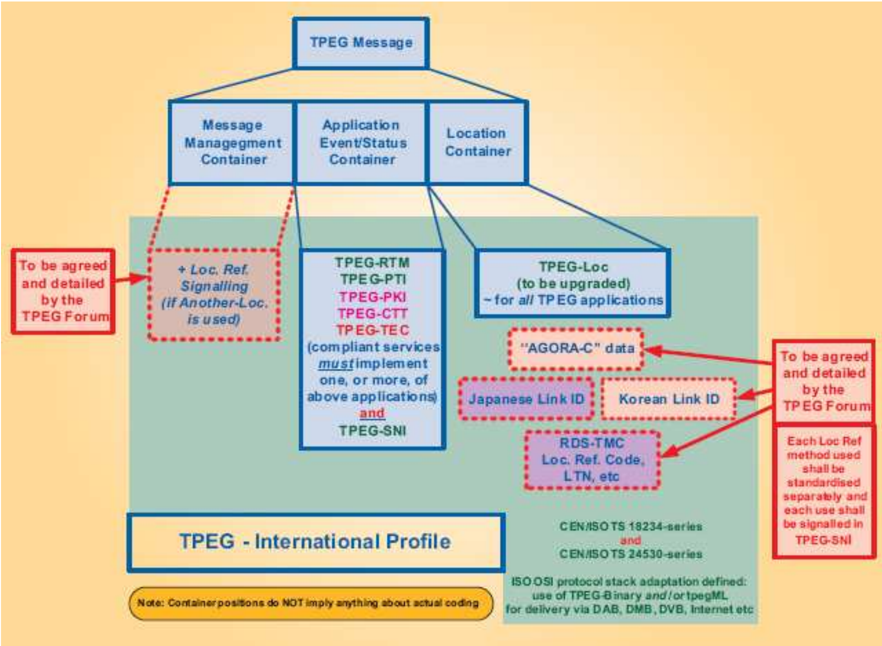
- Does floating cellular data processing really work for real time traffic data delivery?
- Will network operators continue to allow their data to be used by third parties, or will they attempt to monetize it themselves?
- Will the authorities allow personal data showing the movement of individuals' handsets to be sold to companies like ITIS and TomTom, or used for estimating traffic patterns, real-time or historic?



TPEG: The future of traffic data delivery

- TPEG was first developed by the European Broadcasting Union starting in the mid-1990s.
- TPEG development was held back by the lack of a working location referencing method to relate traffic disturbances and incidents to a specific geographic location, and the lack of consumer take-up and government backing for digital radio.

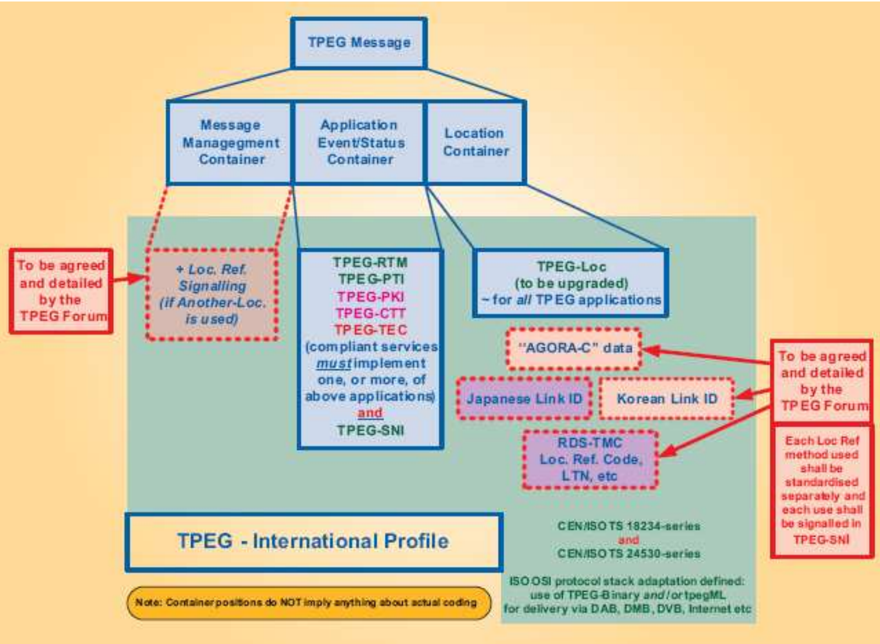
TPEG International Profile



Road Traffic Information Provision

- The FM radio data channel, at 1,200 bits/second and 35-bit data stream per event, was too limiting to use. Data messages are broadcast on a country or region basis, and the total number of messages that can be broadcast is 60 per minute.
- If the broadcast region is reduced in order to increase the total number of messages, the limitation on the total number of location codes per database reduces the addressable locations.
- The process becomes self-defeating.

TPEG International Profile



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Road Traffic Information Provision

- TPEG, which is based on messages that are at least twenty times larger than their ALERT-C equivalents, could not use the FM RDS-TMC channel.
- The move from FM analogue radio to digital radio is the principal reason that this shift to TPEG from RDS-TMC is being proposed at this time.
- Some governments are encouraging terrestrial digital audio broadcasting (T-DAB) while others are either waiting for a more evolutionary solution, like the HD-Radio being adopted in the US, and still others are counting on satellite digital radio to deliver a pan-European solution.

TPEG International Profile

TPEG-Message		
MMC	APC	LRC
Message Management Container	Application Container	Location Referencing Container

TPEG Applications and Standardisation Status

Binary Name	XML Name	Applications	Status
TPEG Binary			CEN/ISO TS 18234-Series Published June '06
	TPEG XML		CEN/ISO TS 24530-Series Published April '06
B/TPEG		"B" relates to internal European Broadcasting Union work, and refers to Broadcasting technology.	TPEG Project- 3 years of validation. Work handed over to TPEG Forum.
TPEG-SSF		Syntax, Semantics and Framing Structure. Establishes frame structure related to ISO/OSI Layer Model.	Part 2 of binary standard
TPEG-SNI	**tpeg-sniML**	Service & Network Information Provides broadcast channel and service information.	Part 3 of binary standard Part 8 of XML standard To be upgraded 2008
TPEG-RTM	**tpeg-rtmML**	Road Traffic Message. Event oriented, like RDS-TMC, and mapped to RDS-TMC. It is hierarchically structured to allow a wide range of service implementations.	Part 4 of binary standard Part 3 of XML standard To be upgraded 2008
TPEG-PTI	**tpeg-ptiML**	Public Transport Information Timetable changes oriented, but does not deliver timetables. Covers bus, train, ferry, air, other public transport. Being used now.	Part 5 of binary standard Part 4 of XML standard
TPEG-LOC	**tpeg-locML**	Location Referencing Based on the ILOC approach developed with in the EVIDENCE Project, which is not suitable for navigation applications. Being upgraded now. Upgraded name to be TPEG-LRC (see below)	Part 6 of binary standard Part 2 of XML standard Being upgraded now

TPEG Applications and Standardisation Status

Binary Name	XML Name	Applications	Status
TPEG-PKI	**tpeg-pkiML**	Parking Information Provides information on parking areas, parking availability (dynamic)	Proposed part 7 and part 5 respectively Not standardised Being developed now, ballot early 2007
TPEG-CTT	**tpeg-cttML**	Congestion and Travel Time Designed to provide speed information on road segments. Korean local standard fixed, May 2006	Proposed part 8 and part 6 respectively Not standardised Being developed now, ballot early 2007
TPEG-TEC	**tpeg-tecML**	Traffic Event Compact Designed to provide efficient transmission of road events. Provides cause and effect information. Oriented toward in-vehicle terminal devices. Based on work being performed in the German national project: mobile.info	Proposed part 9 and part 10 respectively Not standardised Being developed now, ballot late 2006
TPEG-WEA	**tpeg-weaML**	Weather for Travellers Provides a comprehensive weather services, with predictive information available 24 hours ahead. Oriented toward in-vehicle terminal devices. Based on work being performed in the German national project: mobile.info	Proposed part 10 and part 7 respectively Not standardised Being developed now, ballot late 2006

TPEG Applications and Standardisation Status

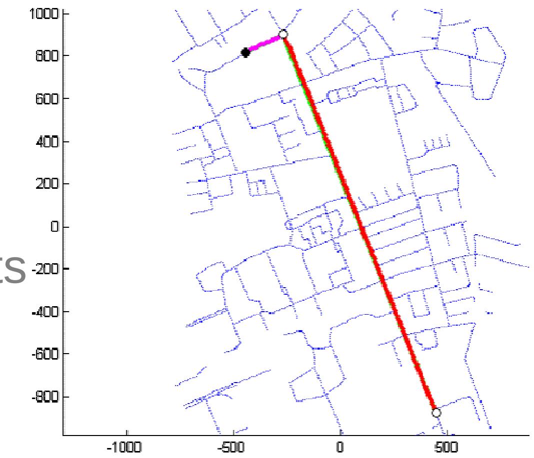
Future Work			
TPEG-CAI	**tpeg-caiML**	Conditional Access Information Transmit meta data to provide conditional access information.	Proposed part 11 and part 11 respectively
TPEG-IDI	**tpeg-idiML**	Infrastructure Disturbance Information Proposed to provide information about disturbances in the power, water and communications grids, how long the disturbances will last, and alternative sources	Proposed part 12 and part 12 respectively
TPEG-MBT	**tpeg-mbtML**	Multimedia Based TTI Proposed to provide images and video clips, particularly for T-DMB delivery channels. Korean development in progress	Proposed part 13 and part 13 respectively
TPEG-BSI	**tpeg-bsiML**	Bus Service Information Provide bus route information, expected travel times Korean development in progress	Proposed part 14 and part 14 respectively
TPEG-SDI	**tpeg-sdiML**	Safety Driving Information Provide information about locations that present dangerous situations for drivers Korean development in progress	Proposed part 15 and part 15 respectively
TPEG-POI	**tpeg-poiML**	Points of Interest Provide information about POIs Korean development in progress	Proposed part 16 and part 16 respectively
TPEG-NWS	**tpeg-nwsML**	News Service Provide news stories categorized for easy search. Korean development in progress	Proposed part 17 and part 17 respectively
TPEG-SPI	**tpeg-spiML**	Speed Information Dynamic and temporary speed information, not static speed limits that are available in the database.	Proposed part 18 and part 18 respectively Being developed now, ballot early 2007

AGORA and AGORA-C

Location Referencing for Traffic Messaging, Map Updating

- On-the-fly location coding
- Further development of EVIDENCE
- References multiple types of locations
- Provides for Intersection Points, Routing Points and Location Points
- AGORA-C location references less than 50 bytes—AGORA resulted in larger sizes

Typical urban Location coded with AGORA



Location Reference example:

Road work in Hanover

- ➔ 3 Points
- ➔ 12 Attributes
- ➔ 55 Bytes message size

AGORA-C

The coding of a location according to the rules of AGORA-C consists of attaching the following attributes:

- Location Type (e.g. Intersection, POI, Road)
- Number of intermediate intersections
- Directional Reference (Positive, Negative, Both)
- Functional Road Class (FC0=main, etc.)
- Form of Way (e.g. Motorway, Roadabout, etc)
- Road Descriptor (Street Name, Road Number)
- Heading (in degrees)
- Parallel Carriageway Indicator
- Intersection Type (e.g. Freeway, Roundabout, etc.)
- Routing Point Distance (distance to next routing point)
- Routing Point Direction Flag
- Road Descriptor of Side Road
- Side Road Heading
- Side Road Direction Flag
- Road Descriptor of Roundabout (Name, Road Number)
- Driving Direction (aligned with heading; reverse of heading)

Traffic Information Provision: Mobile.Info

TPEG with Mobile.Info

BMW Group
EW
20.10.2004
Page 20

Science and Traffic

Project Mobile.Info / 3D (DAB Data Distribution).

- Goals of the project
  - Platform for the **efficient distribution** of unidirectional telematics services (e.g. road traffic information)
  - First steps towards reaching a **critical mass** for telematics services
- Project partners
  - German companies with a strong interest in **significant improvements** of **road traffic information services**
    - Car manufacturer and their supplies
    - Service providers and network operators

BMW Group
Science and Traffic

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Digital Radio

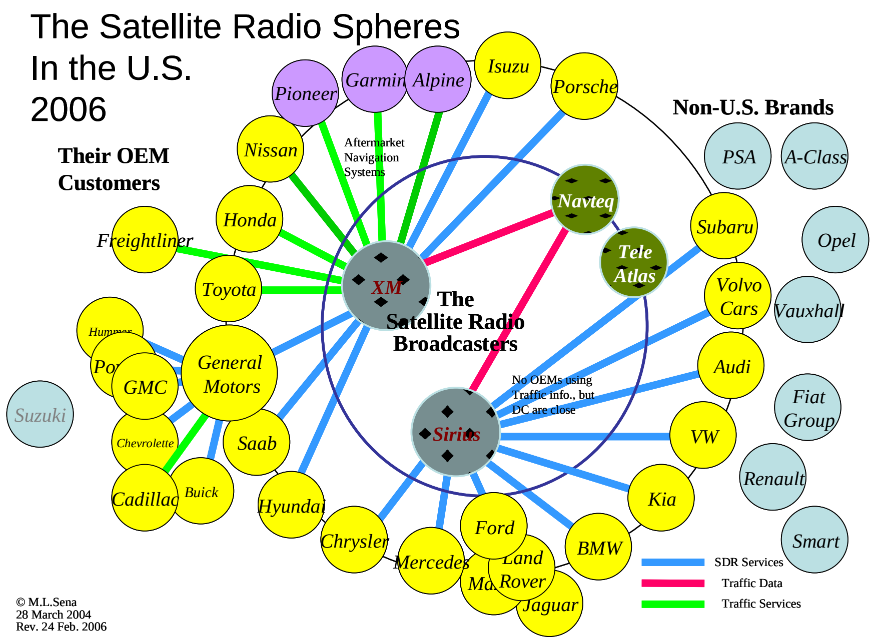
- What is DAB? **DAB** is **D**igital **A**udio **B**roadcasting. According to the *DAB Association*, it is a "method for the digital transmission of radio signals". The analogue radio sound signals are converted to a series of ones and zeros prior to sending, and decoded to sound at the receiving end. The intention is that digital radio will eventually replace analogue radio in the same way that digital television is replacing analogue TV.
- DAB is a broadband channel, 1.54 MHz, with data rates up to 1.2 megabits per second (Mbps). Compared to GSM, which is 9.6 kilobits per second (kbps), and GSM/GPRS, which is effectively 50 kbps, data transfer rates with DAB are significantly faster, and more data can be transmitted in the data packages.

Digital Radio

- DAB was first developed within a European research project called EUREKA in the late 1980s, and it is currently being implemented in countries around the world, including all European countries, Australia, Singapore, Taiwan, South Korea, China and India, and in the Americas in Canada, Mexico and Paraguay. It is not being implemented in the United States nor in Japan.
- In the U.S., the Federal Communications Commission has recommended adoption of its own standard called HD Radio (originally called IBOC for In Band On Channel). HD radio uses existing FM radio transmitters, and allows both analogue and digital signals to be transmitted simultaneously.
- While Terrestrial-DAB is viewed as an option in some European countries, the U.S. Federal Communications Commission has ruled that it is not to be made available in the U.S. because it does not provide an evolutionary path from the current AM/FM analogue broadcasting. The alternative to T-DAB is HD Radio, which offers 96 kilobits per second data transfer rates

Digital Radio

- It is important to distinguish between two forms of DAB, Terrestrial-DAB and Satellite-DAB. T-DAB is the technology that is currently being implemented in the countries listed above. S-DAB, also called Satellite Digital Radio (SDR), is the technology behind Sirius and XM Radio in the United States.
- The main difference is that T-DAB, as the name implies, relies on ground transmission towers, while SDR uses satellites for transmissions with supplementary ground towers in areas where line-of-site is difficult, such as deep canyons, both natural and man-made.



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Digital Radio

- Digital Radio Mondiale (DRM) – A digital replacement for AM radio. It is not a competitor to DAB as a digital replacement for analogue FM.
- Digital Video Broadcasting (DVB). DVB-T (Terrestrial) is intended for home and in-vehicles receivers, and DVB-H (Handheld) is intended for battery-powered portable devices, such as phones and PDAs.
- DVB-T is already a threat to DAB because it provides similar services as DAB, and often uses the same frequencies assigned to DAB.
- DVB-H could provide an opportunity for phone-based data delivery in the vehicle.

T-DAB

- Opel – The first T-DAB radios were introduced in the Astra in 2004.
- Ford – Dealers sell DAB radios in the U.K.
- BMW/Mercedes/Audi – These companies have been involved in a project called Mobile.Info in Germany where DAB services are being investigated and tested.

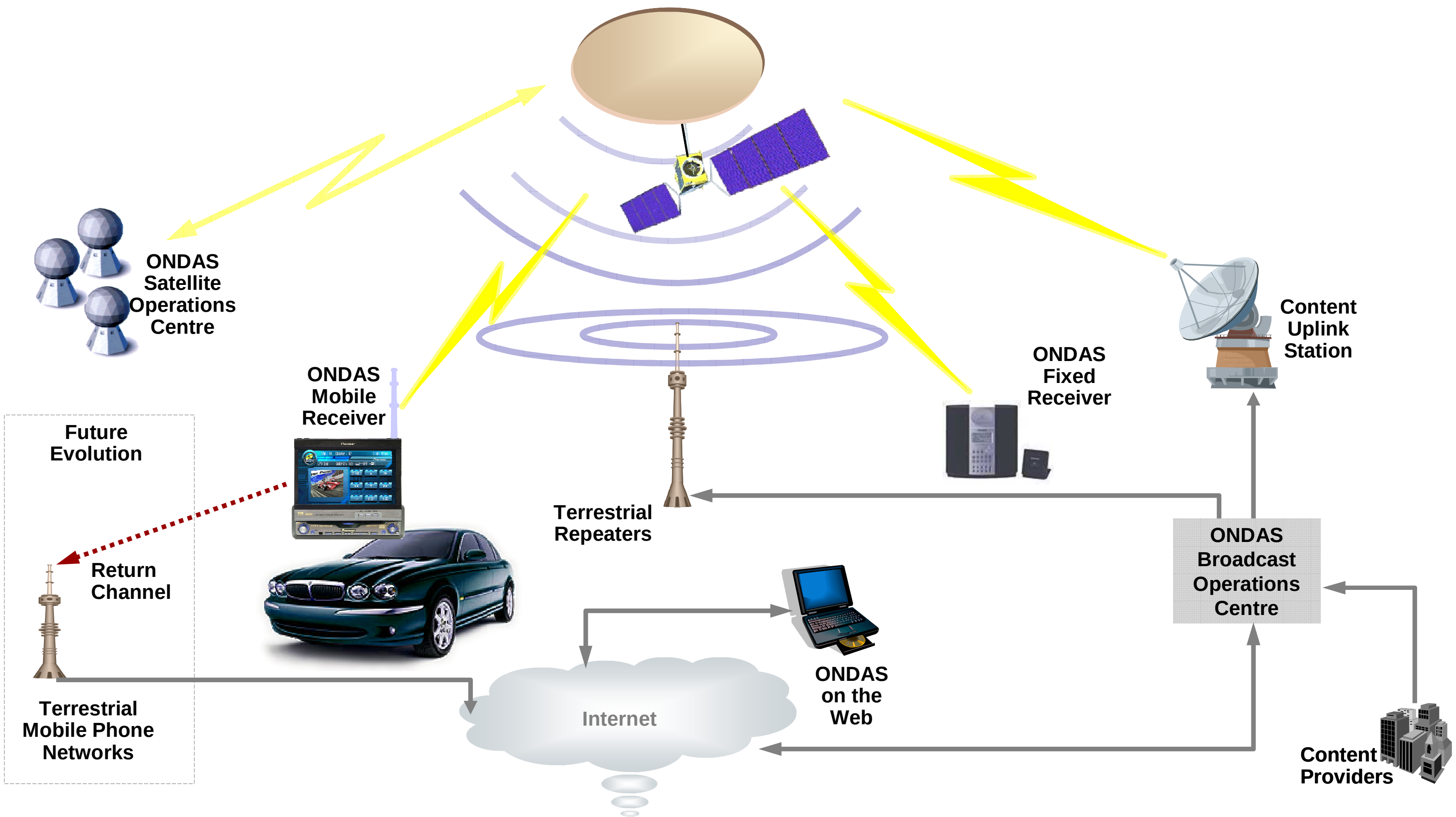
SDR

- In North America, both Navteq and its competitor Tele Atlas are delivering traffic information to vehicles via satellite radio. Initially
- Twenty-two metropolitan areas are being covered, but both companies are assembling data for additional areas. Navteq plans to have over fifty cities in its service by 2007.

Digital Radio

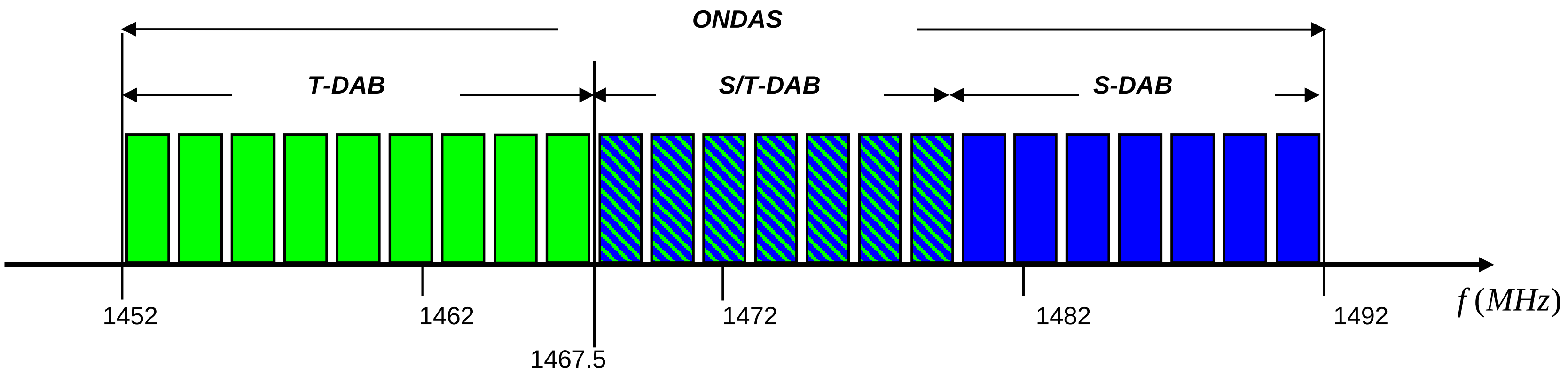
Advantages of DAB over Analogue and T-DAB over Satellite Radio	
Analogue Radio	**Satellite Radio**
▪Sound quality can be significantly better than FM ▪No interference between stations that are close in frequency, and no fading signals ▪Access to more radio stations ▪Data, audio, text and video services can be offered with T-DAB because of wide bandwidth ▪More features available with T-DAB	▪T-DAB is free while S-DAB will be subscription-based ▪Programming is country-specific with T-DAB and in local language, while S-DAB will have to use channel capacity to broadcast in country-specific languages ▪The shift from FM to T-DAB for the broadcasters is relatively easy, although costly, while S-DAB is very costly
Disadvantages of DAB versus Analogue and T-DAB versus Satellite Radio	
Analogue Radio	**Satellite Radio**
▪Consumers must purchase new radios ▪The technology is more costly for all parties	▪Access is continent-wide for voice, video and data transmission, so pan-European services can be provided. ▪High quality sound is guaranteed ▪Multiple languages can be broadcast simultaneously ▪It is compatible with both T-DAB and Analogue radio, while T-DAB is not compatible with S-DAB.

Satellite Digital Radio System Overview

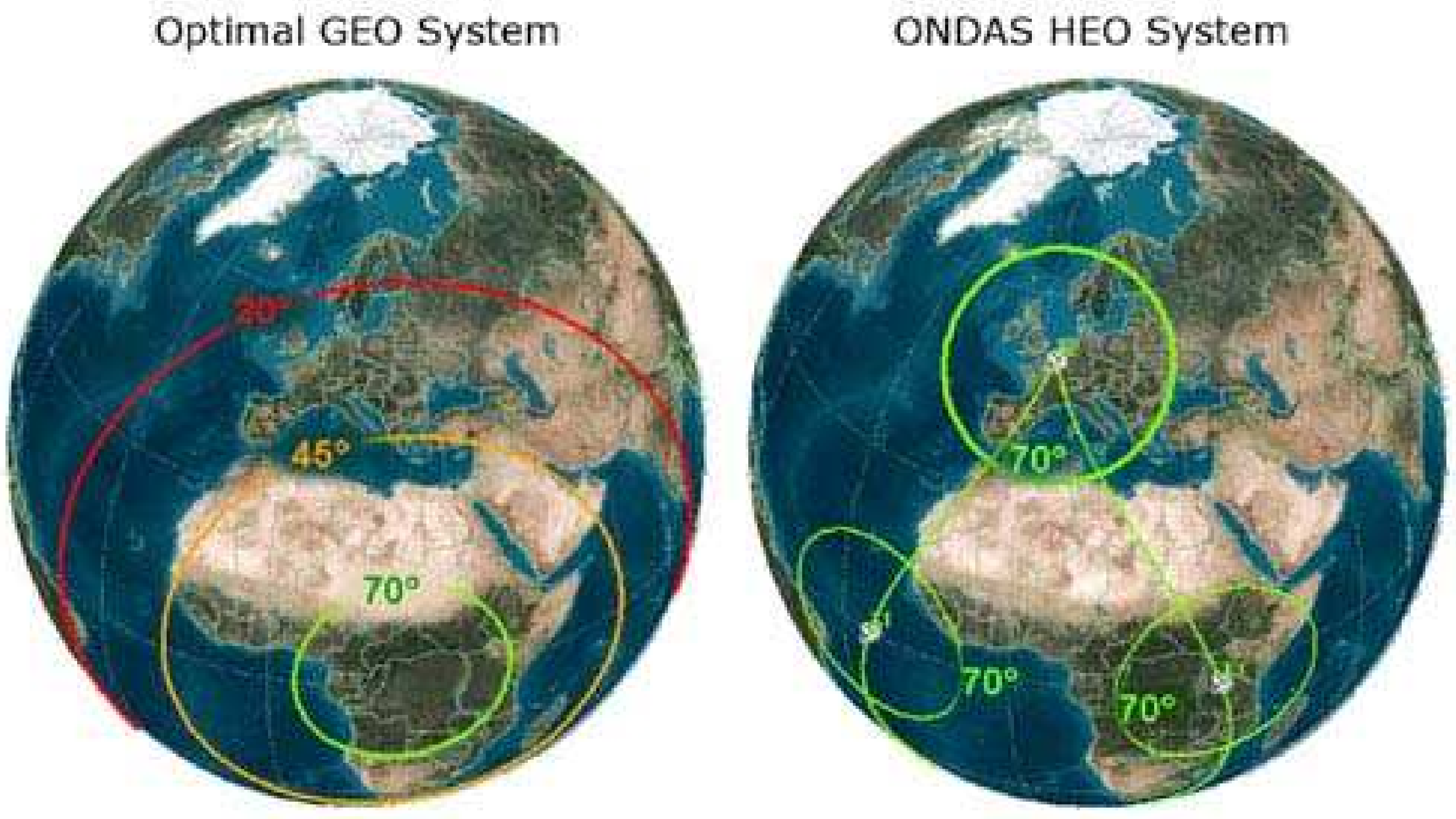


European L-Band SDARS Spectrum

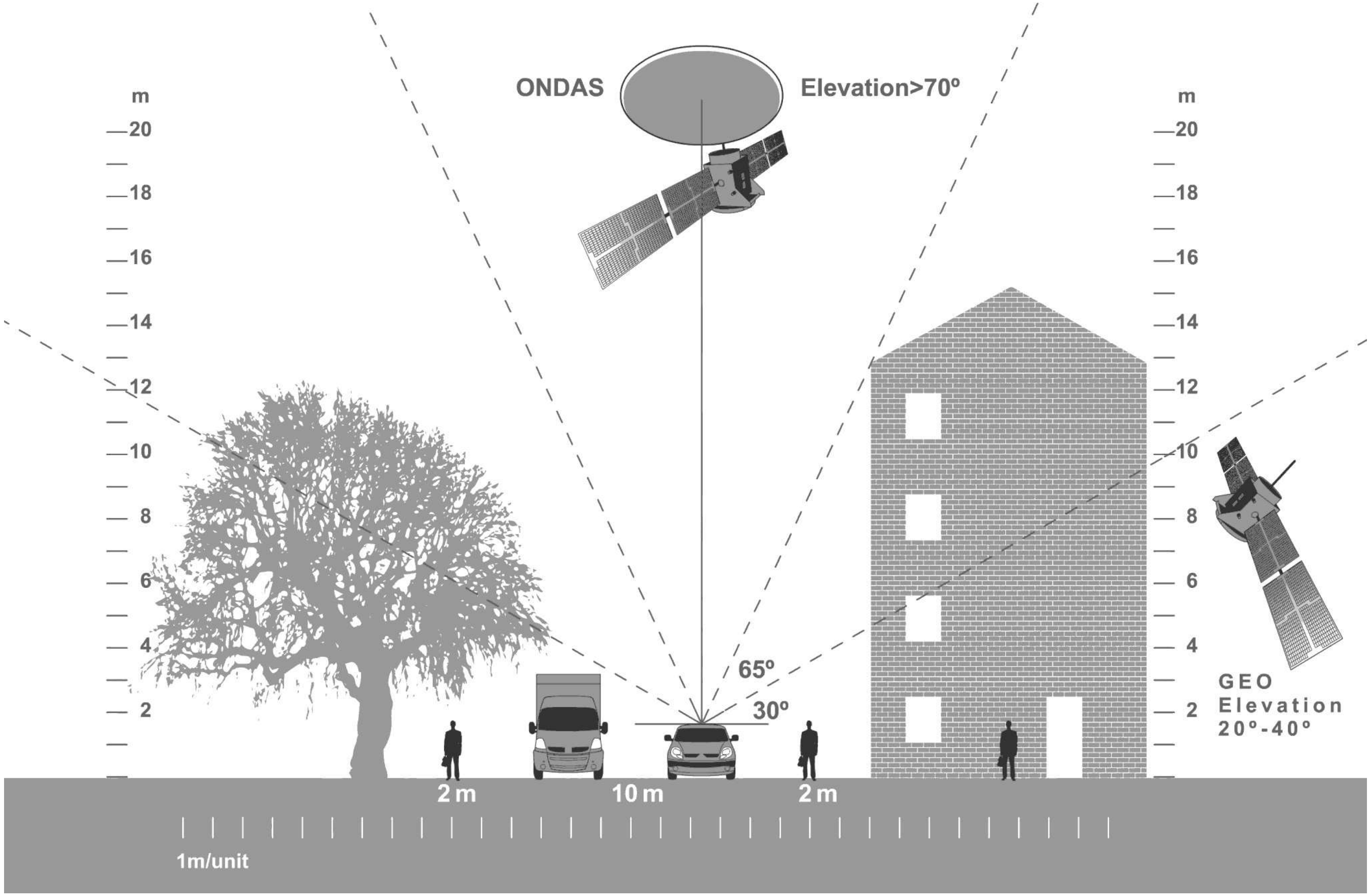
- Flexible satellite payload will be capable of operation in a minimum of any seven and up to ten MUXes in the upper fourteen blocks
- Each block/MUX can support an average of 30 channels (i.e. over 200 channels)



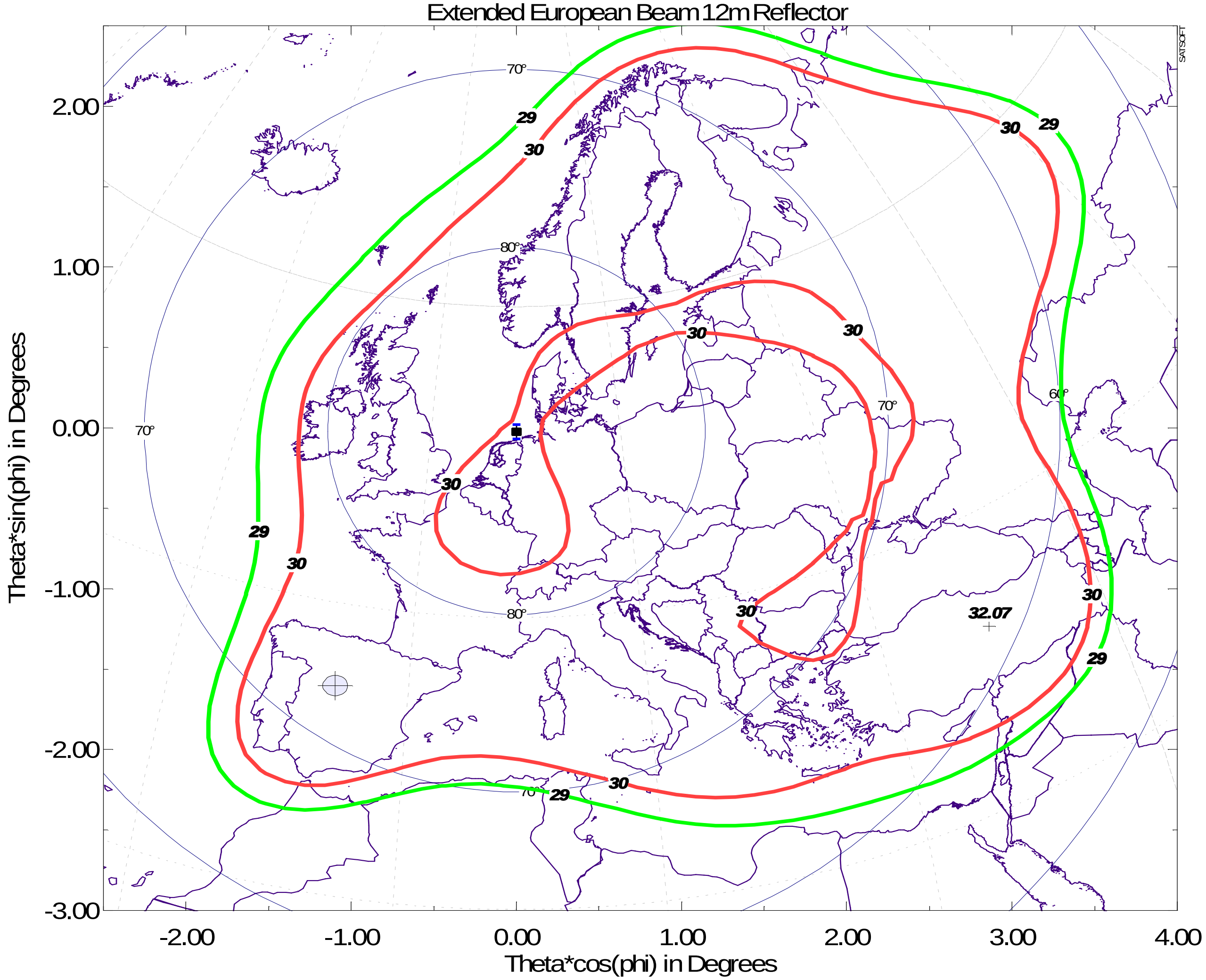
Satellite Technologies



Benefits of HEO v. GEO



ONDAS Extended Coverage



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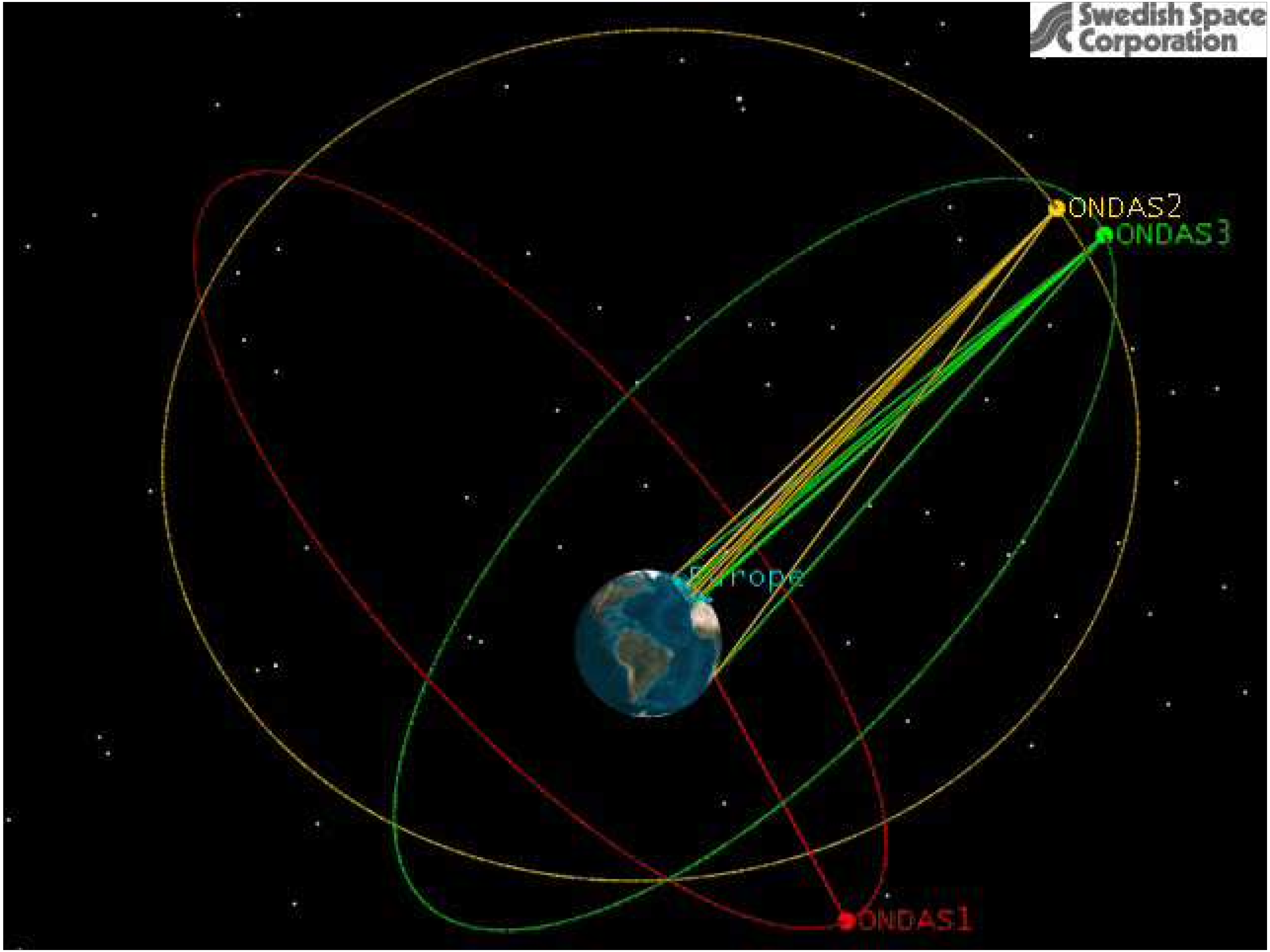
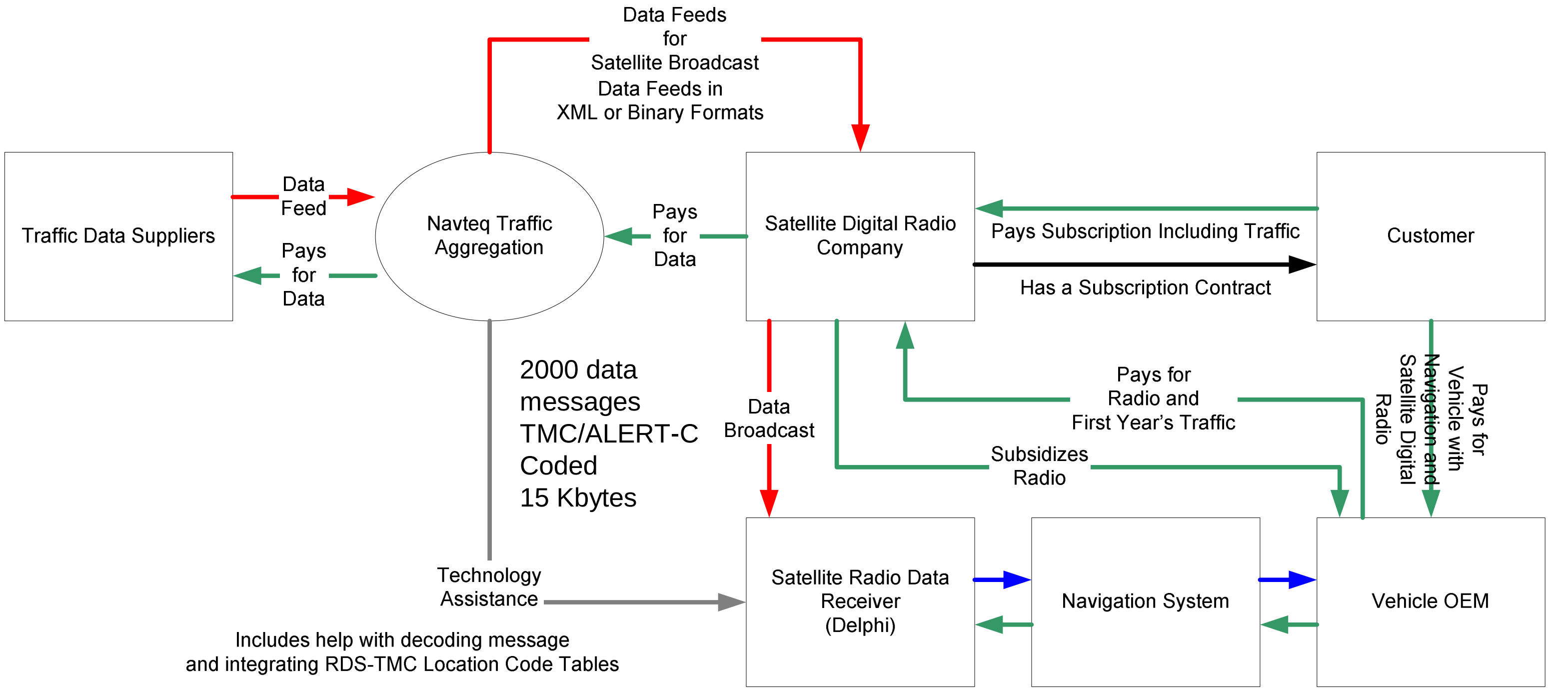

Swedish Space Corporation
ONDAS2
ONDAS3
Europe
ONDAS1

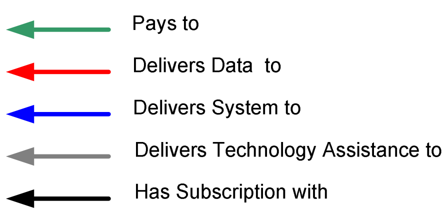
The SDRS Data Delivery Model in the U.S.

Dynamic Traffic Information Process Flow in U.S. Market: Navteq Traffic

16 May 2006

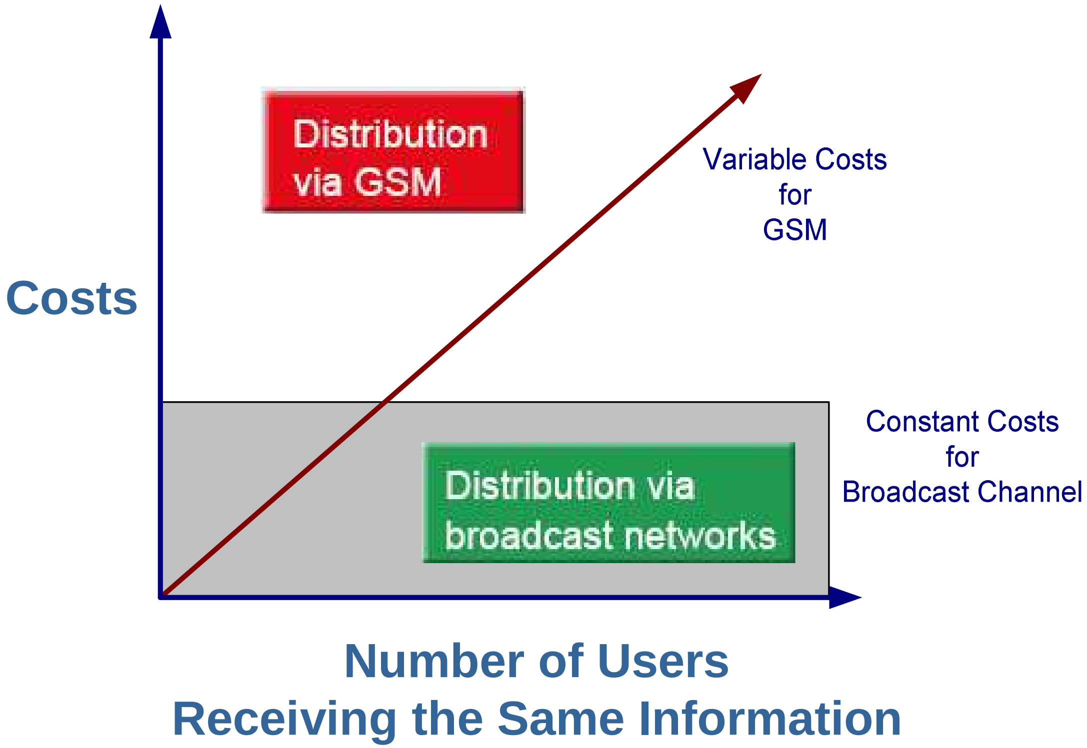


Standard RDS-TMC FM Broadcast
TMC/ALERT-C Coded
5 bytes/message – 60 messages per minute on a 1200 bits per second netowrk.



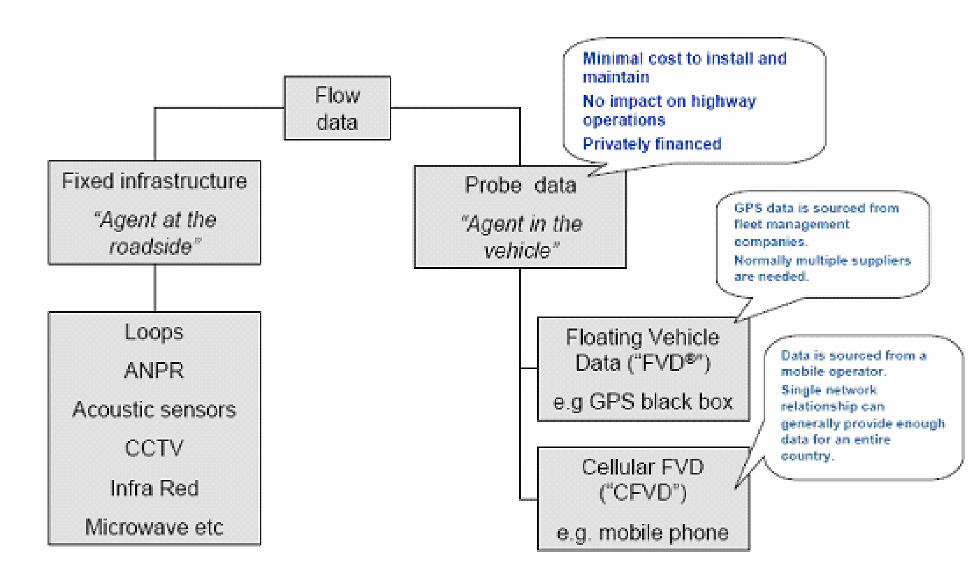
Broadcast versus Telecommunications for Data

- Deliver continuous stream of traffic and other dynamic data
- Download the latest maps for the area where a customer is driving.
- Download guidebook information for a region or town.
- Download software that the customer needs for the specific country or terrain



Modelling Traffic

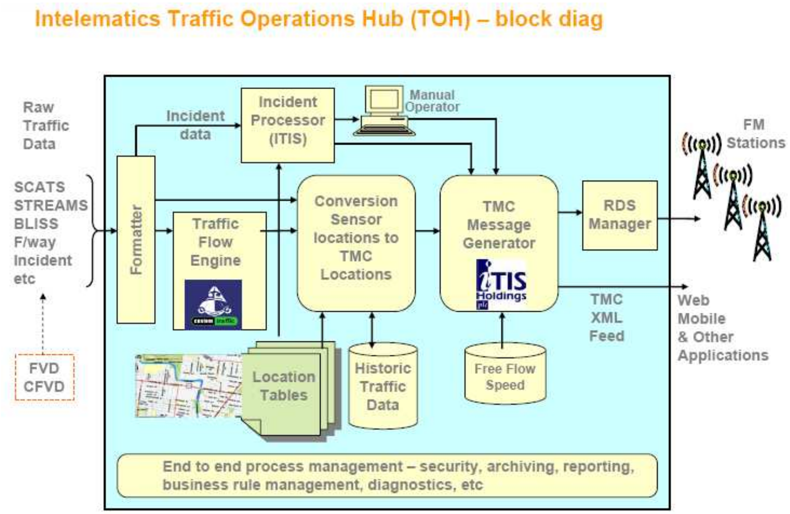
- Traffic planners have been modelling traffic patterns for well over half a century.
- Their objective is to decide where to expand capacity and remove obstructions.
- Individuals perform a type of traffic modelling in their heads whenever they get into their car to mak a journey.
- Helping navigation systems to think about what they should suggest today based on what happened yesterday, or last month or last year is what modelling is all about.



Source: ITIS Technologies Ltd.

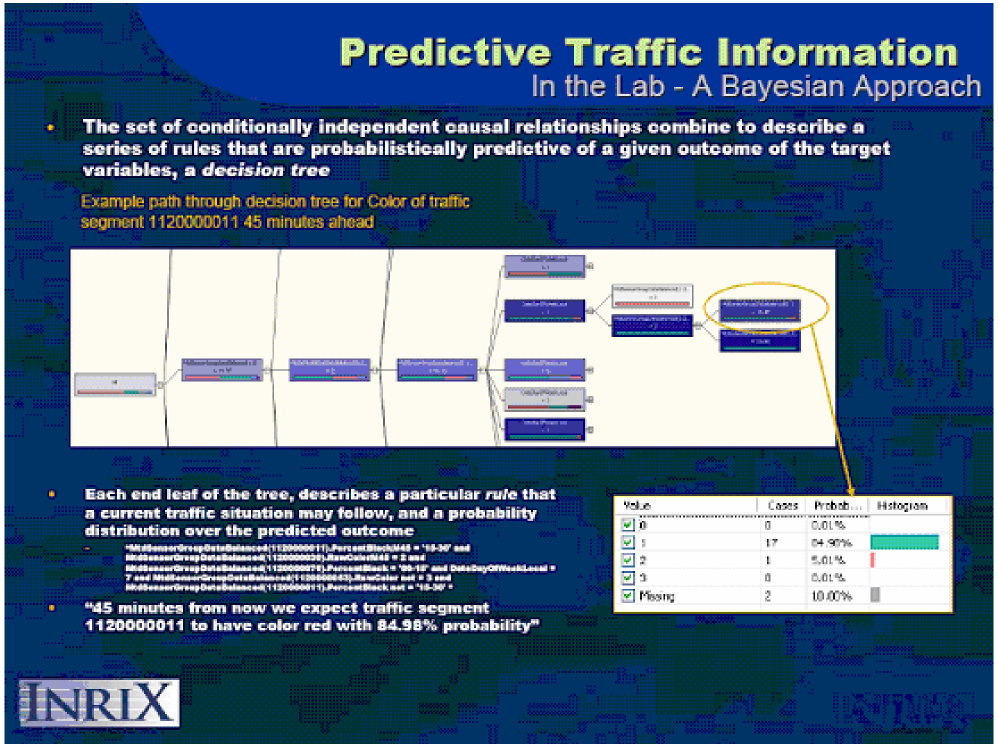
Predictive Modelling of Traffic

- Real-time data alone does not provide good enough routing.
- Real-time traffic data is difficult and costly to acquire, and unless it is transferred from a flow-based system, it may not reach travellers until it is too late for them to take appropriate action.
- Daily commuters know when certain stretches of roads will be jammed with traffic, and they select alternate routes to avoid these road segments at those times when they are normally congested, but drive these same segments at other times of the day or week when traffic flows freely on them.



Modelling Traffic

- There is a great deal of activity at this time, both in Europe and in North America, to collect speed of flow data and to record it as an attribute in the data base so that it can be used for predictive route planning.
- Navteq in the US has its Navteq Traffic Patterns, TomTom, through its acquisition of Applied Generics, has a cellular-based data collection system, ITIS Holdings has both cellular- and floating vehicle-based data collection. Inrix claims to have special algorithms that do the job better than any of its competitors.



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Eyes in the Sky

Exactly what is happening on the road in front of me?

- The first traffic data collectors were reports flying around in helicopters, like the Sikorsky above.
- Maybe it's time to consider what we are trying to convey to the users of traffic information.
- We are spending a great deal of time and money to collect traffic event and flow data and to present it to individual drivers, when perhaps the most effective way to accomplish this is to let the drivers see the situation for themselves.
- New technologies may make this possible. See The Economist November 3rd 2007: *The fly's a spy*

Unmanned Aerial Vehicles

- The Exdrone system is a low-cost reconnaissance unmanned aerial vehicle designed for militar purposes.
- It is a delta platform flying wing air vehicle that is 5 feet long and has a wingspan of 8 feet, powered by a small one-cylinder, two-cycle, air-cooled engine with a two-blade propeller.
- The flight control system consists of a UHF uplink receiver connected to a Global Positioning System (GPS) based autopilot. It has three modes of operation: Manual flight, manual override autopilot, or full autonomous.

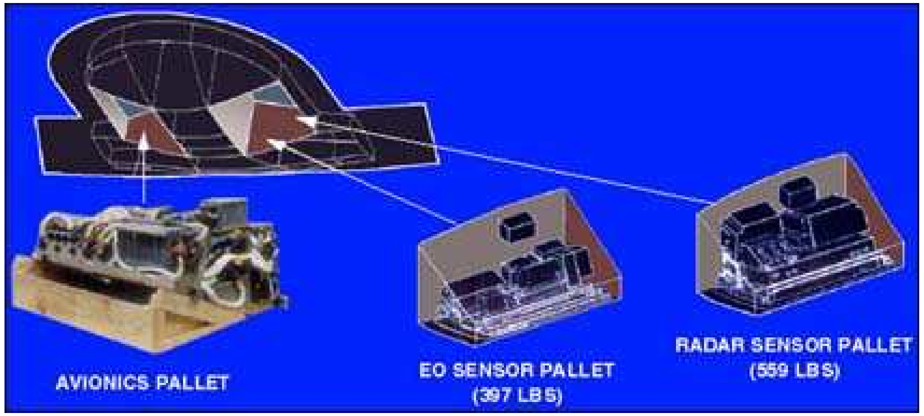
BQM-147A Exdrone
Dragon Drone

The Exdrone began as a research and development effort to build a low-cost expendable drone capable of carrying a VHF communications jammer. The aircraft have since been modified with several different payloads to provide reconnaissance.

Unmanned Aerial Vehicles

- The Exdrone has a launch weight of 89 pounds and a 25 pound payload capacity. The vehicle service ceiling is 10,000 feet, however, the mission altitude is usually between 3,000 - 4,000 feet above ground level.
- One of the payloads is the Pulinex TM-7i down-looking color TV camera, a commercial-off-the-shelf color camera providing 570 lines of resolution and a six power zoom lens.
- Other payloads available include an Image Intensifier, and Forward Looking Infrared (FLIR) cameras.

RQ-3A DarkStar Tier III Minus



The Tier III Minus UAV, known by the nickname DarkStar, is a system is a high-altitude, endurance unmanned air vehicle optimized for reconnaissance

Unmanned Aerial Vehicle

- Onera, the French national aerospace centre, is developing a miniature robotic aircraft, code named REMANTA, that will be small enough to fly into a room through an open window and film the goings on of the room's occupants.
- It is not a large stretch of the imagination to a small personal UAV that could climb up from the roof of a car to a few thousand feet to beam back images of the road ahead.

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Unmanned Aerial Vehicle

Onera, A police helicopter weighing less than a kilo will be trialled in Liverpool as part of an attempt to cut antisocial behaviour.

The Microdrone MD4-200 is under a metre long and can be equipped with a 10-megapixel camera, digital video or low-light and infrared units.

The device can also be fitted with a GPS unit and sent on pre-programmed flights without a human operator.

"We are always looking at ways of putting more officers on the streets, and maximising technology is a powerful way of achieving this," said Simon Byrne, Assistant Chief Constable of Merseyside Police.

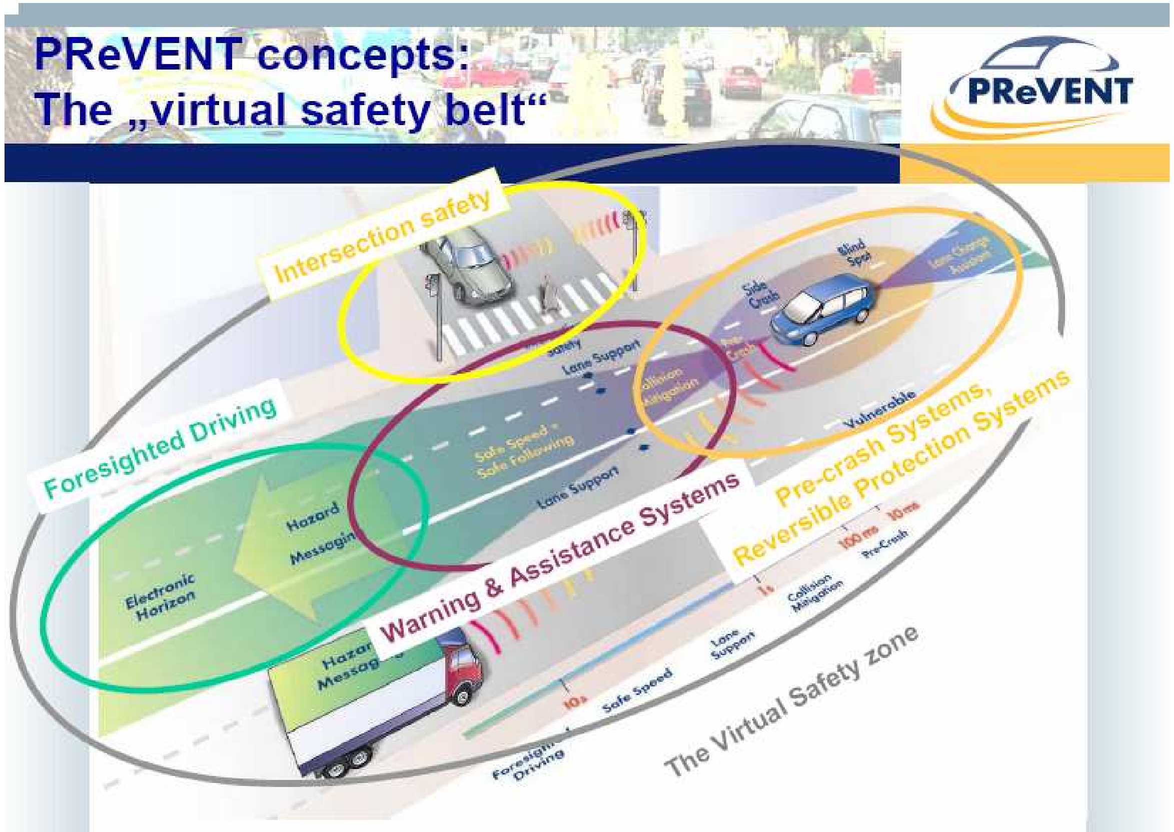
"The drone will support our Axis antisocial behaviour taskforce in gathering important evidence to put offenders before the courts.

"Other uses may include monitoring public disorder, crowd control during large scale events, and use during traffic congestion."

Merseyside Police is already using CCTV-equipped vans in Liverpool to gather evidence, and the new drones will

Vehicle-to-Vehicle Communications

- Vehicles that have experienced an incident, or *sense* that there are problems with the road surface, can signal cars in the vicinity, behind and ahead of the dangerous condition.
- Vehicle-to-vehicle communications short-cut the data collection and verification process and provides up-to-the-minute information



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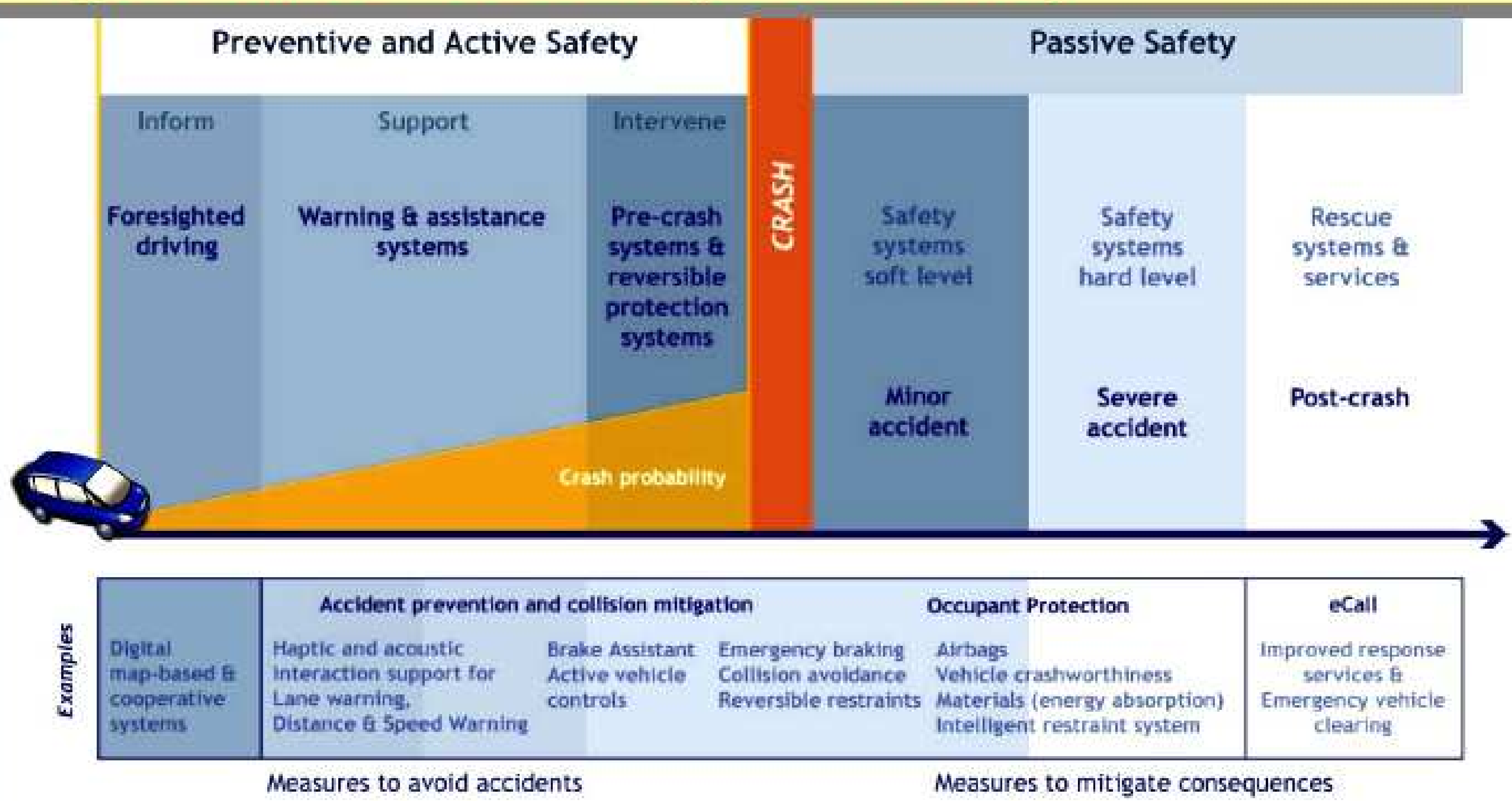
Harmonised progression of interventions and integration of preventive, active and passive safety

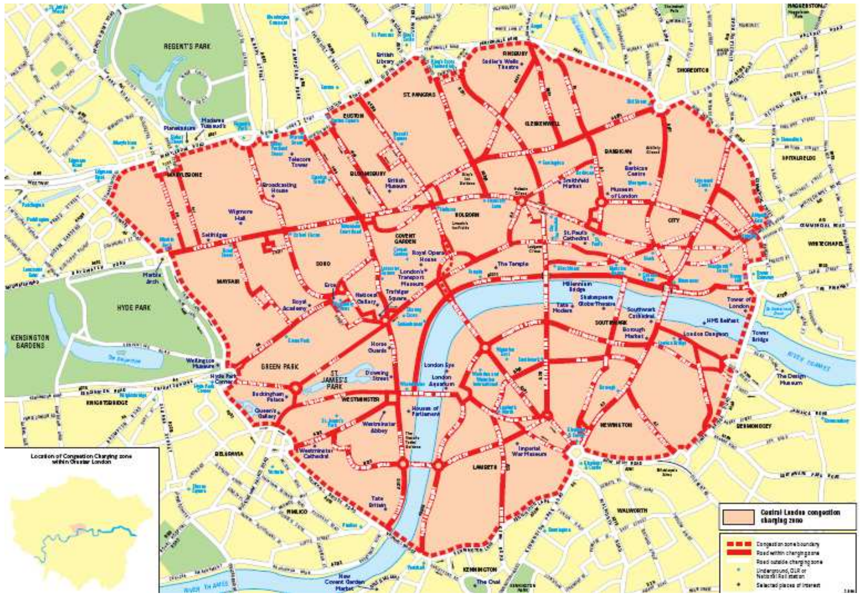


A Future Navigation System

- Navigation systems have reduced the stress of wayfinding that we drivers had when we were using paper maps folded over steering wheels and street signs that were often hidden or not there.
- But blinding following turn-by-turn instructions can also be stressful, especially if an instruction is confusing or just plain wrong.
- The most effective navigation instruction is still “Go to a place you can see.”, or “Go to a place that you know.”.

Is Congestion Charging an answer?

- Who gains from congestion charging zones?
- What is the ultimate purpose of charging drivers for entering and exiting from the congestion zones?
- What are the real short-term and long-term effects of charging drivers for moving in and around cities?
- What can we learn from historical precedents?
- What are the alternatives to charging drivers for doing what they have done for free.

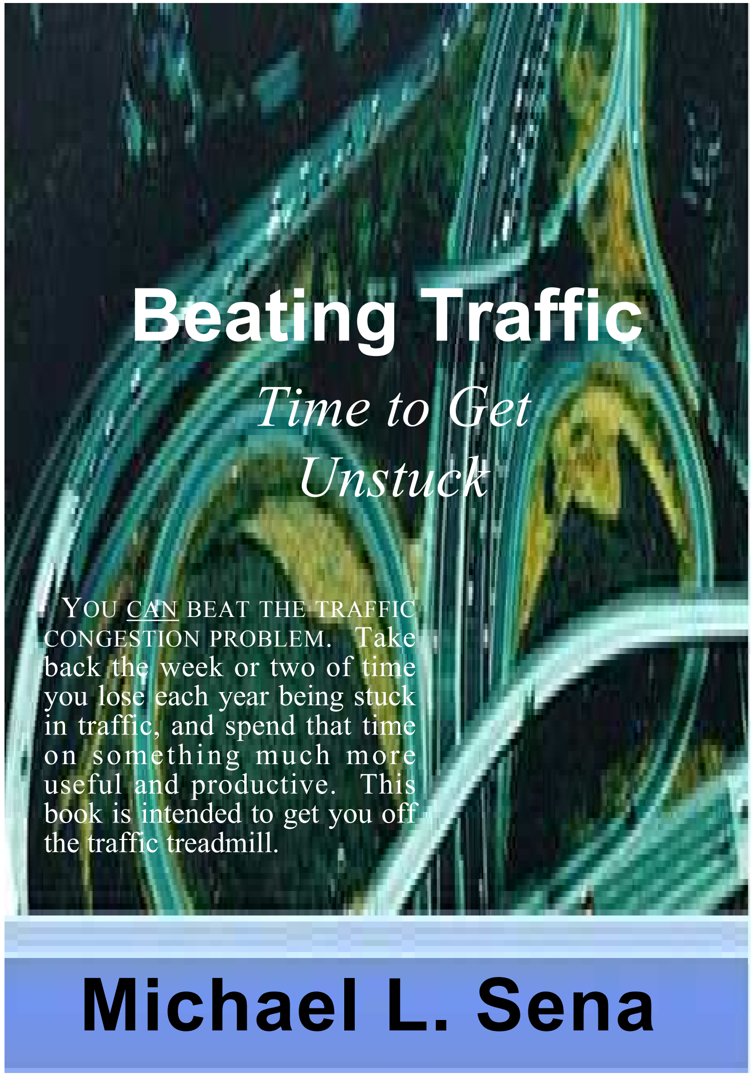


The original London Congestion Charging Zone .

Two ways to beat traffic congestion

A normal Saturday on the main street in Tokyo's Ginza shopping district.

A normal anyday in the virtual world of 3D navigation visualisation.



Questions

Thank you.

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Prepared for the IQPC

Advanced Navigation Conference Berlin

November 2007

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Michael is an internationally recognised expert in telematics, digital map databases, location-based services and navigation. He has owned and run a successful consulting practice since 1983 with clients in Europe, North America and Asia in the automotive, software, system development, service and database industries. He served as an expert delegate to both the European CEN and international ISO standards committees, and has participated in and managed international ITS projects. He is project manager for IVSS-SOLVI.